USN SUBMARINE VS IJN ANTISUBMARINE ESCORT

The Pacific, 1941–45

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INTRODUCTION

Undersea combat was one of the most important aspects of the entire Pacific War. Despite its importance, the United States Navy's (USN) submarine campaign against the Japanese Empire is often overlooked. While the history of the failed German U-boat campaign to strangle the shipping lanes in the Atlantic has reached epic proportions, the undoubted success of American submarines in the Pacific goes somewhat unrecognized. After a faltering start, the USN's campaign of unrestricted submarine warfare was so successful that by 1945 a strong case can be made that it had made Japan's surrender all but inevitable. The USN effort to strangle Japan's seaborne trade, led by submarines, remains the only successful submarine anti-commerce campaign in history.

When it entered the war in December 1941, the USN had 112 submarines in commission. Half of this seemingly impressive total consisted of boats dating back to just after World War I. Several factors, principally conservative tactics and faulty torpedoes, translated into meager results in the final month of 1941 and all of 1942. USN submarines—known as fleet boats—used tactics geared to integrate them into supporting fleet operations, which required them to attack Japanese fleet units. Prewar training supported this requirement and was based on the accepted wisdom that modern sonar, depth charges, and aircraft made submarines extremely vulnerable. Given this, USN submarine captains were penalized for showing aggression since detection meant destruction of their boats. Lack of aggression by submarine skippers was a continuing problem throughout the war. Ineffective skippers were gradually weeded out and replaced with younger, much more aggressive officers to command the growing number of submarines in service.

In parallel with the lack of aggression was a severe problem with the standard submarine torpedo, the Mark 14. This weapon was deeply flawed with three major

problems. In the confusion and stress of war, these proved very difficult to identify and remedy. It was not until September 1943 that the Mark 14 became a reliable weapon. Another factor reducing the initial effectiveness of USN submarines was flawed employment. Once USN senior commanders learned to focus submarine operations on the principal objective of attacking shipping instead of dispersing submarine operations all over the Pacific on various missions, their effectiveness grew. Even with the incalculable advantage of code breaking that gave submarine commanders exact knowledge of the movement of Japanese convoys and naval forces, overall shipping losses remained tolerable for the Japanese through 1943.

In 1944, a storm enveloped Japan's merchant marine. When aggressive captains using new tactics were combined with reliable torpedoes, more Gato-class boats, superb intelligence on Japanese naval and shipping movements, and the development of advanced radar suitable for employment on submarines, the results were devastating. USN submarines used their many advantages to utterly ravage Japanese shipping. The invasion of the Mariana Islands made advance bases available that allowed submarines to tighten the blockade in the vital Luzon Strait chokepoint. Though the penetration of Japan's inner defenses also brought American airpower to bear against Japanese shipping, submarines remained the deadliest agent for destroying Japanese merchants, eventually accounting for 55 percent of Japanese shipping losses. By the end of 1944, the flow of resources from Southeast Asia to Japan had virtually stopped.

The calamity that engulfed Japanese shipping was a predictable disaster. The Imperial Japanese Navy (IJN) assigned a very low priority to antisubmarine warfare (ASW) before the war. This remains incomprehensible since Japan was heavily dependent on shipping to feed its war industries and even its population. The early failures on the part of the USN's submarine force seemed to confirm the IJN's assessment that it could gain a decisive victory and end the war before shipping losses curtailed Japan's ability to continue the war. Given this grace period, the IJN failed to address its many weaknesses in ASW. The IJN never had enough escorts to protect shipping, never developed advanced tactics to deal with a sustained submarine threat, and lacked modern sensors and weapons to deal with American submarines. By the time the Japanese gave ASW the priority the situation demanded, it was too late. In 1944, considerable numbers of mass-produced ASW escorts entered service, but these were relatively ineffective. While losses of USN submarines were heavy (at least proportionally for a relatively small force), they never curtailed American operations and provided no relief to Japanese shipping. The result of this neglect to defend Japan's lifeblood in an extended war was the immolation of Japan's merchant marine. In 1945, the few remaining Japanese merchant ships were pinned in home waters, and any trade outside the Home Islands had stopped.

Salmon-class boat *Seawolf* had a long combat career. On her first four patrols as part of the Asiatic Fleet, she made three claims, but these were all later denied. On her next 11 patrols, she recorded 17 confirmed sinkings and another shared kill, making her tied for seventh in the number of ships sunk. In October 1944, she was sunk by "friendly" fire. This is one of her early victims, probably *Gifu Maru* sunk on November 2, 1942. (Naval History and Heritage Command)

CHRONOLOGY

1941

December 8	USN submarines are ordered to commence unrestricted warfare against Japan.
December 10	*Sealion* is sunk by Japanese air attack at Cavite Navy Yard in the Philippines, becoming the first USN submarine lost during the war.
December 31	Asiatic Fleet submarines retreat to the Netherlands East Indies (NEI) after their failure to defend the Philippines.
December 1941 –August 1943	The Mark 14 torpedo aboard USN submarines is plagued by problems, greatly reducing the effectiveness of the entire force.

1942

March	Asiatic Fleet submarines withdraw to Fremantle, Australia after their failure to defend the NEI.
December	USN submarines account for 180 Japanese merchant ships since the start of the war for the loss of seven subs.

1943

June 24	Admiral Chester Nimitz orders the deactivation of the magnetic exploder on the Mark 14 torpedo.
October	First USN wolf pack sent from Pearl Harbor.
November	IJN establishes Grand Escort Command Headquarters.
December	USN submarines account for 335 Japanese merchant ships in 1943 for the loss of 15 subs.

1944

June	USN submarines are critical in the defeat of the IJN in the Battle of the Philippine Sea by tracking Japanese movements and sinking two fleet carriers.
October	USN submarines play a major role in the Battle of Leyte Gulf, sinking three IJN cruisers and damaging two.
December	USN submarines account for 603 Japanese merchant ships in 1944 for the loss of 19 subs.

1945

August 6	*Bullhead* becomes the last of 52 USN submarines lost during the war.
August	USN submarines sink 1,113 merchant ships and 214 IJN warships during the war in exchange for 43 subs sunk by Japanese forces.

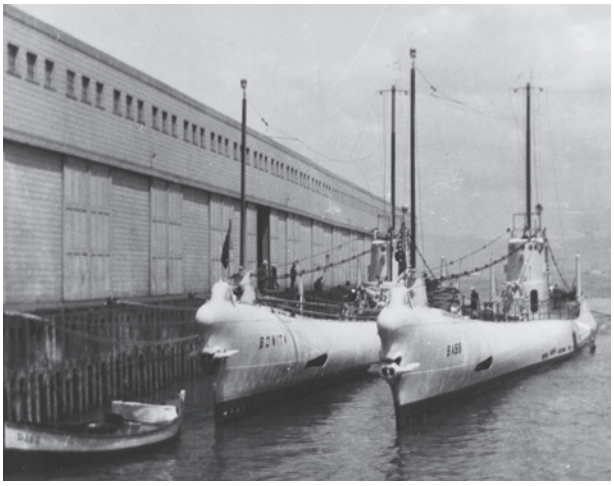
DESIGN AND DEVELOPMENT

USN SUBMARINES

The oldest USN boats to see combat service in the Pacific War were the S class, commissioned from 1918 and 1924. There were four variants within the 51 boats of this class, with a displacement of between 840 and 870 tons, a length of 219–31ft, and a top surface speed of 15kn from two diesel engines. These were still primarily coastal submarines, as their endurance was limited to 5,000NM at 10kn. Armament consisted of four torpedo tubes with a torpedo capacity of 12, and either a 3in. or 4in. deck gun. Despite their obsolescence at the start of the war, some were assigned to combat duties in secondary areas and remained in the front line until late 1943, when they were replaced by newer boats and assigned to training duties.

The next group of submarines to enter service were the nine boats of the V class. These were originally intended to operate in conjunction with the main battle fleet, which placed speed at a premium. However, a lack of funding lengthened their construction to between 1921 and 1934. Because of this, the original design was subjected to new requirements and then to

S-44 underway in June 1943 off the Philadelphia Navy Yard after her last overhaul. The boat's sail has been modified, and radar has been fitted. The deck gun is a 4in./50. *S-44* was sunk by IJN destroyers on her fifth patrol in October 1943. (Naval History and Heritage Command)



Bass (outboard) and *Bonita* photographed at San Francisco, California, in the early 1930s. These were two of the USN's first three fleet boats. They were disappointing in service, and spent most of the war on training duties. (Naval History and Heritage Command)

the restrictions of the 1930 London Naval Treaty. As a result, the nine boats were completed in three groups and five different classes. Built with the numbers *V-1* through *V-9*, they were given names in 1931.

The first three were commissioned between 1924 and 1926 as *V-1* to *V-3*. They were large boats with a surface displacement of over 2,100 tons and a length of 335ft. With two diesels providing power, they were designed to make 21kn on the surface. In service, they proved disappointing. Their machinery was unreliable and they failed to make either their design surface or submerged speed. For a large boat, they only carried six torpedo tubes and 12 torpedoes. Endurance was also unimpressive—6,000NM at 10kn. They were also poor sea boats. As the *Barracuda*, *Bass*, and *Bonita*, they were decommissioned in 1931. They returned to service at the start of the war, but after a few defensive war patrols, all three were relegated to training duties. *V-1* to *V-3* laid claim to being the first 'fleet' boats.

The next group of V-class boats were built for an entirely different purpose. These were designed to be capable of long-range independent reconnaissance and attack missions. From bases on the West Coast or Hawaii, operations off Japan were envisioned, which obviously made endurance paramount. Design specifications called for a boat with a patrol endurance of 90 days, a range of 17,000NM at 10kn, and an offensive punch of 30 torpedoes and mines. Congress only approved a handful of these large boats. The first, *V-4* (later renamed *Argonaut*), was the largest USN submarine until the advent of nuclear power. Submerged displacement was greater than 4,100 tons with a length of 381ft. The boat was heavily armed with 16 torpedoes, two 6in./53 deck guns, and a capacity to carry 60 mines. In service, the boat's diesels proved unreliable, and were replaced early in the war. The minelaying system was removed and the boat converted into a transport submarine.

FLEET SUBMARINES AND ENDURANCE

The USN placed a premium on endurance for its submarines. Endurance included several factors, not just the obvious one of fuel to provide range. Other factors included provisions for the crew and carrying enough torpedoes for sustained attacks. As a matter of course, the USN considered three torpedoes necessary for each of the bow tubes and two for the stern tubes. To gain the required number of reloads, some submarines carried torpedoes in watertight containers external to the pressure hull. Seventy-five days was considered the minimum endurance for a submarine.

Fleet submarines were those with the necessary endurance and speed to work with the main fleet. Operating with the fleet meant that the submarines could attack the enemy's main fleet in a large-scale engagement. The cruising speed of the USN's battle fleet was about 12kn, since this was the speed of the accompanying fleet train. If the submarine had a sustained speed of 15kn, it could easily keep up; a maximum speed of 17–18kn would come in useful for pre-attack maneuvering.

Only two more cruiser type boats, *V-5* and *V-6* (later *Narwhal* and *Nautilus*), were approved. These were similar to *V-4* but had the minelaying system removed. In its place were two stern torpedo tubes and eight additional torpedoes. The boats met their design speed of 17kn, but the diesels continued the USN's early pattern of unreliability with regards to diesel propulsion.

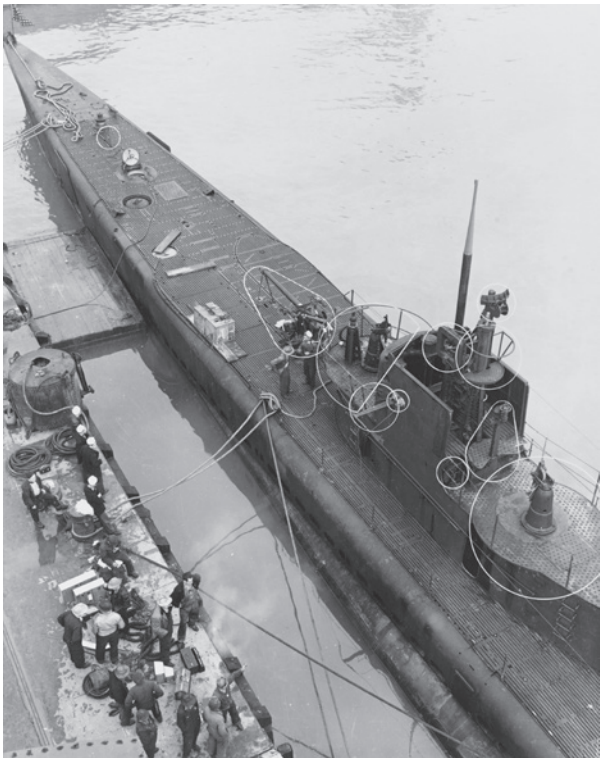
Following the construction of *V-6*, USN submarine design took a very different course. The handful of V-class boats built were large, expensive, and complex—they could never be built in the numbers required for a war with Japan. This view was firmly held by the submarine force, which preferred a smaller submarine suited for mass production. To meet the demands of the submariners, a design was generated that was in between the earlier S class and the large cruiser boats of the V class. The result was *V-7* (later *Dolphin*). This resumption of the fleet boat concept had a range of 11,000NM, 75 days patrol endurance, six torpedo tubes with 18 total torpedoes, all on a hull of 1,570 tons. *V-7* was considered a mobilization design and was capable of patrols across the Pacific from Hawaii. Though unsuccessful in service, primarily due again to the poor reliability of her diesels, *V-7* was the first of the 1,500-ton boats that later became standard.

By the time the final two V-class boats were ordered, the London Naval Treaty was in effect. Just like it did for all types of warships, the treaty impacted USN submarine design. The maximum displacement of any submarine was set at 2,000 tons; total USN submarine tonnage was limited to 52,700. Because the seven existing V-class boats took 16,000 tons of the USN's submarine allocation, construction of more large cruiser submarines was impossible without curtailing the overall number of submarines available.

The desire to build an adequate number of submarines forced a new design based on a German submarine from World War I. The new design was smaller at 1,100 tons but carried six tubes and 16 torpedoes, possessed an endurance of 75 days and a range of 11,000NM at 10kn, and achieved a top speed of 17kn. Only two boats were built to this design, being completed in 1934 as *V-8* and *V-9* (later *Cachalot* and *Cuttlefish*). In service, they were disappointing. Their diesels were unreliable and were replaced in 1938. During the war, they proved too cramped for Pacific patrols. After only three patrols, they were sent to spend the rest of the war in training commands.

Lack of funding during the early years of the Great Depression gave the USN two years to consider its next submarine class following the failure of the *Cachalot* and *Cuttlefish* design. The next class was driven by improvements in propulsion technology. Instead of the previous direct-drive configuration with only two diesels, the new boats carried an innovative diesel-electric propulsion system in which four diesels drove electric motors via generators that drove the shafts. This system had many advantages, like being able to shut down each of the diesels in turn for maintenance on long patrols. However, the system did require more space and a larger number of crewmen to service it. This drove the size of the next class to 1,300 tons. Four boats were built to this design, named after the lead boat *Porpoise*. The first two were built in Portsmouth Navy Yard with a conventional double riveted hull. The next two were built by Electric Boat with a welded pressure hull and became a sub-class named after *Shark*.

The rapid progress in USN submarine design in the 1930s was fostered by competition between the private Electric Boat Company and the government's



Early in the war, USN fleet boats underwent modification. This is *Pompano* at the Mare Island Navy Yard on December 24, 1942. The white outlines on the photo mark recent alterations; note the addition of radar and two 20mm mounts. On her seventh patrol to waters off Japan, *Pompano* never returned, probably after striking a mine. (Naval History and Heritage Command)

Portsmouth Navy Yard. Given the same general design specifications, the result was the Portsmouth-built *Porpoise* and *Pike* and the Electric Boat-built *Shark* and *Tarpon*. Electric Boat units used General Motors engines, while Portsmouth designs used Fairbanks-Morse engines.

The next class of six boats (the Perch class) was divided between the two yards. It was a virtual repeat of the previous class, but with the addition of air conditioning for the entire boat. This was a huge factor in crew habitability on long Pacific patrols. All these boats carried six tubes and 16 torpedoes, with an endurance of 75 days and a range of 11,000NM.

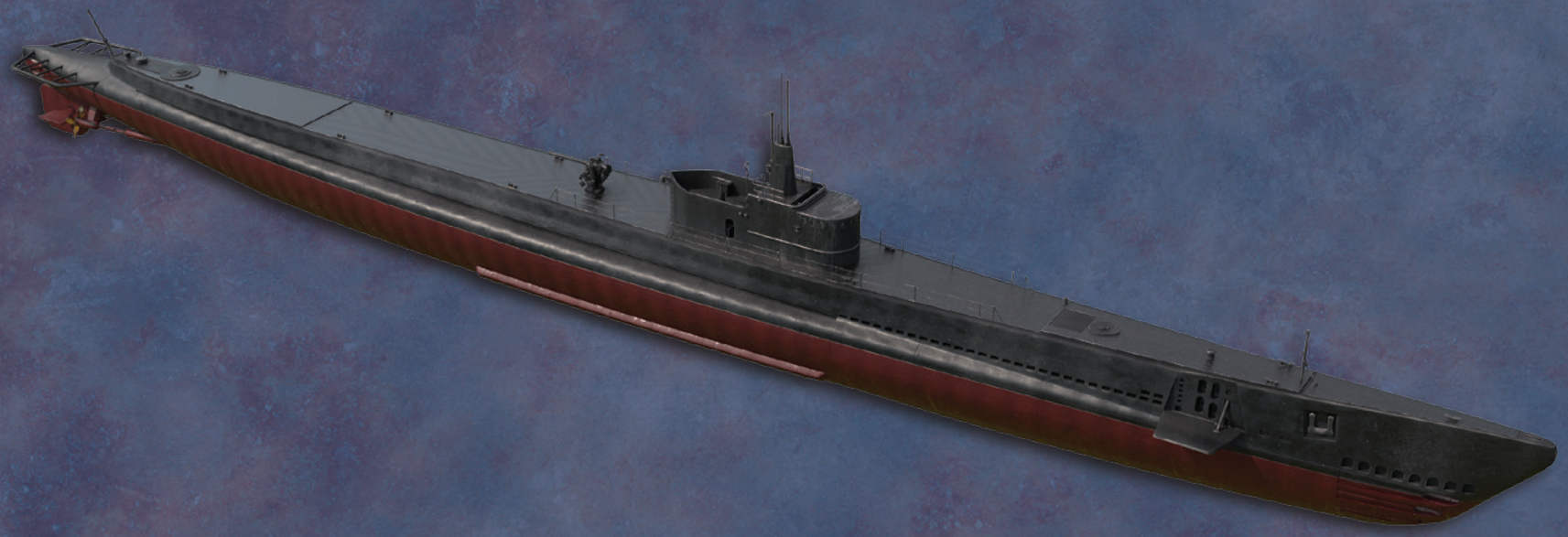
A desire to increase firepower and surface speed led to changes on the Fiscal Year (FY) 1936 class, named after *Salmon*. With another 120 tons of displacement, the number of stern tubes was increased to four, and total torpedo capacity increased from 16 to 24. Four of the stern reloads were carried in external containers. To meet the requirement for increased surface speed and to offset the additional weight, a new propulsion system was adopted. This was a 'composite' system with two diesels directly driving the shafts via reduction gearing complemented by two diesels powering electric generators and driving the shafts through the same reduction gearing. The result was a top surface speed of 21kn. The composite system was more complex and less flexible than the previous diesel-electric system. The FY 1937 Sargo class of six boats kept the composite system, but the FY 1938 Seadragon class of four boats reverted to diesel electric.

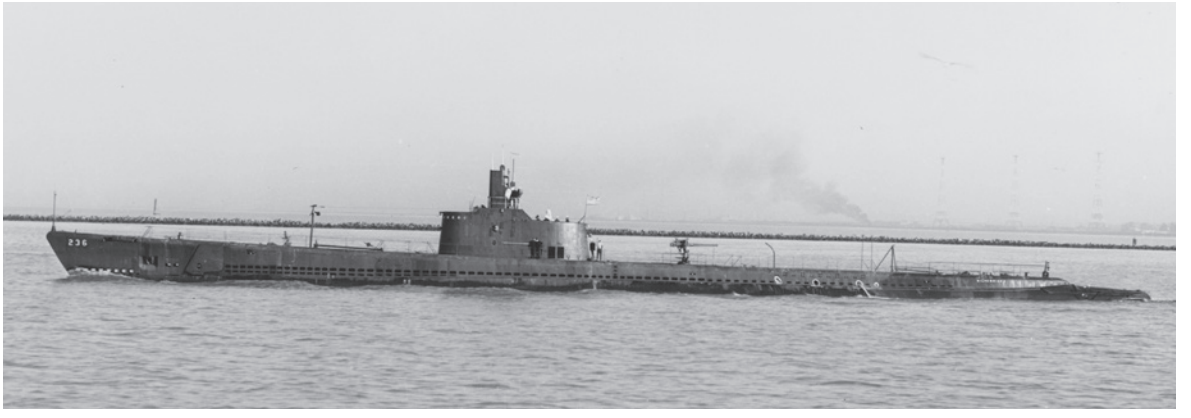
Twelve Tambor-class boats were funded in 1939 and 1940. This was the culmination of the fleet boat series and provided the basis for wartime mass production. Significant improvements were made in combat capabilities, including an increase in the number of forward tubes to six, fitting a larger deck gun, new sensor capabilities in the form of a better periscope and sonar, and a better fire-control system. With only minor modification, this led to the Gato class, which totaled 77 boats. The first six were repeats of the Tambor class ordered as part of the FY 1941 program. These were lengthened by 5ft to allow the engine room to be divided into two smaller compartments, but otherwise were identical to the Tambor class. Another significant improvement was the decision that the hulls were able to safely operate down to 300ft.

Mass production of the Gato class was followed by the Balao class—the largest class of USN submarines ever built. Two hundred fifty-six were ordered, but only 119 were completed by six different yards. The Balao class was virtually identical to the Gato class externally and internally. The major difference was indiscernible to the eye, but it represented a significant upgrade of the new boats' warfighting capabilities. Balao-class boats were completed using high-tensile steel on their pressure hulls instead of the previous mild steel. The additional strength increased operating depth to 400ft.

EARLY GATO-CLASS SUBMARINE

The most important USN submarine of the Pacific War was the Gato class, of which 77 were built. Twenty of these were lost in combat. This view depicts a Gato-class boat in its early-war configuration. Note the large sail, the lack of antiaircraft guns and radar, and the single 3in./50 gun aft of the sail.





Silversides shown in her early-war configuration, off Mare Island Navy Yard on March 31, 1942. With her 23 confirmed sinkings, *Silversides* ranked third in sinkings and fifth in total tonnage. (Naval History and Heritage Command)

Another enhancement halfway through the Balao construction program was an increase in torpedo storage that brought total capacity to 28 weapons.

The fleet boat series reached its final refinement with the Tench class. The first were ordered in 1943 but not laid down until April 1, 1944. As the end of the war approached, of the 147 authorized, only 80 were ordered, and 25 completed. Externally they were indistinguishable from the late Gato-class or Balao-class boats. Internal differences were incorporated to reduce vulnerability to flooding. To alleviate the potential weakness of generating excessive noise from high-speed electric motors and reduction gear that could be detected by passive sensors, low-speed electric motors were fitted that used direct drive to drive the shafts. This new propulsion system greatly reduced noise.

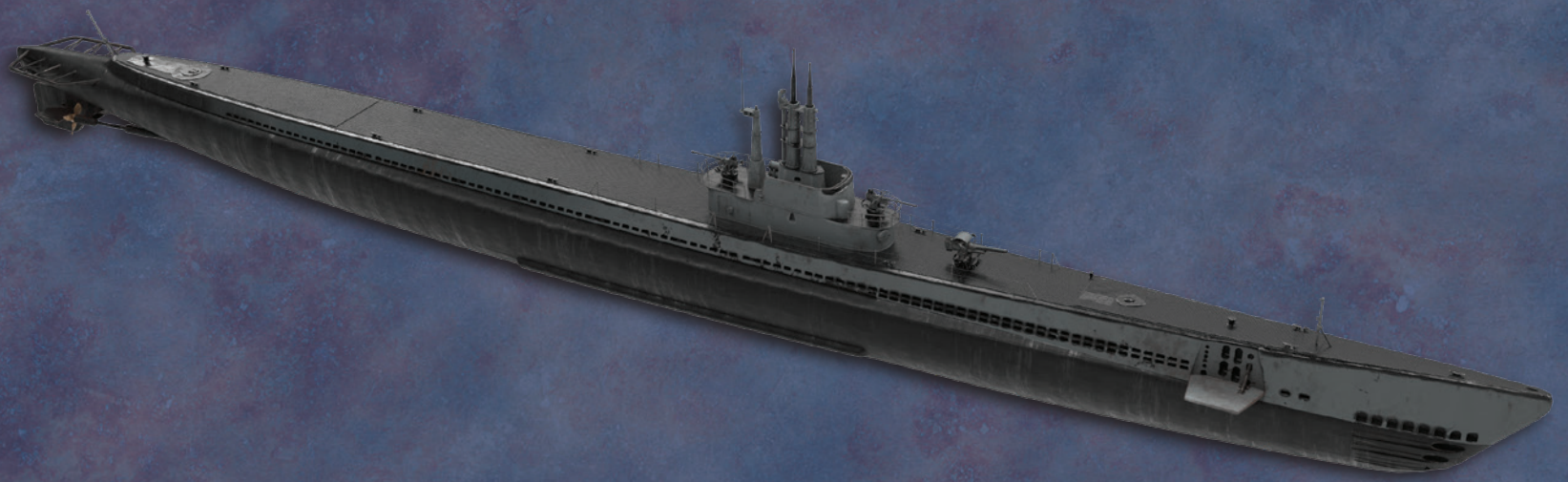
USN SUBMARINE WEAPONS

The offensive punch from American submarines came from their two major weapons: the torpedo and the deck gun. The most important of these was by far the torpedo, and it was in this area that the USN experienced major difficulties. The standard wartime torpedoes were the Mark 10 and Mark 14. The Mark 10 was a straight-running torpedo that required the firing submarine to be pointed directly at the target. This torpedo carried a 497lb warhead and had a top speed of 36kn out to a maximum range of 3,500yd. The Mark 14 torpedo was a massive improvement, at least theoretically. It had two speeds—31.5kn and 46kn—that were selected prior to firing. It could make one course adjustment after being fired that meant maneuvering the submarine to point the torpedo was not part of the firing solution. Both the speed and turn selection was performed manually or electrically via the fire-control computer from the conning tower. The Mark 14 torpedo had a 660lb warhead filled with Torpex with a range of 4,500yd at high speed and 9,000yd at slow speed. In practice, the torpedo was almost always set for 46kn with little, if any, gyro angle.

The Mark 14 torpedo used the Mark 5 and Mark 6 exploders; the Mark 5 was a contact exploder and the Mark 6 was a magnetic influence exploder. The magnetic exploder was designed to detonate the warhead under the keel of the target, which was potentially much more deadly than a torpedo hitting the side of the ship. Both exploders had serious design flaws; combined with the fact that the torpedo ran as much as 10ft below the set depth meant that American submariners fought the first

LATE BALAO-CLASS SUBMARINE

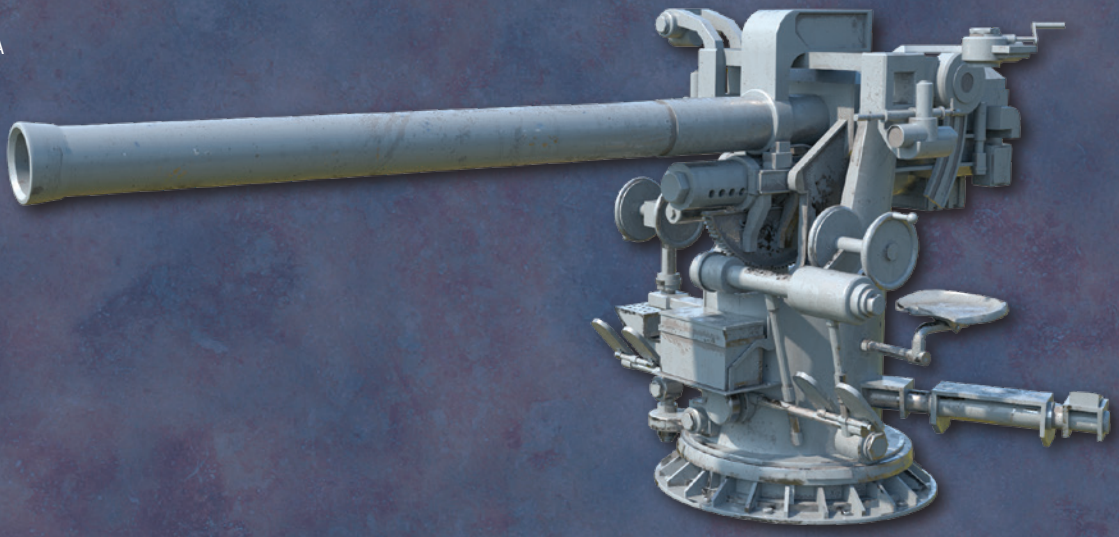
The Balao class was a late-war variant of the Gato class. As completed, it was identical to Gato-class boats already in service. As the war progressed, both classes were modified. The sail was cut down to reduce diving time and visibility on the surface and to provide room for antiaircraft guns. This is a late-war configuration depicting a typical fleet submarine arrangement with a single 5in./25 deck gun aft, one single 20mm gun on the forward bridge deck, and one 40mm on the after bridge deck. Two periscopes are visible; abaft them is the SJ radar mast.



USN SUBMARINE WEAPONS

(A) At the start of the war, most USN submarines carried a wet 3in./50 deck gun (shown here). The gun lacked hitting power and was disliked by submarine crews. It was soon replaced by a 4in./50 gun, which also lacked hitting power. (B) The Mark 14 torpedo was the standard USN submarine torpedo at the start of the war. Its troubles and the struggles of submarine crews and skippers to fix them have become legend. It was a large weapon weighing 3,280lb with dimensions of 21in. diameter and 20ft 6in. length. It carried a warhead with 643lb of torpex.

A



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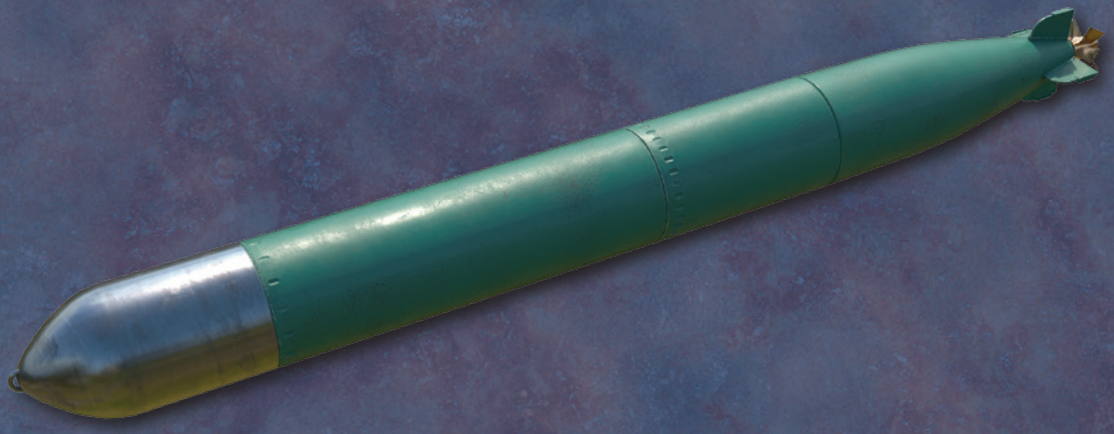
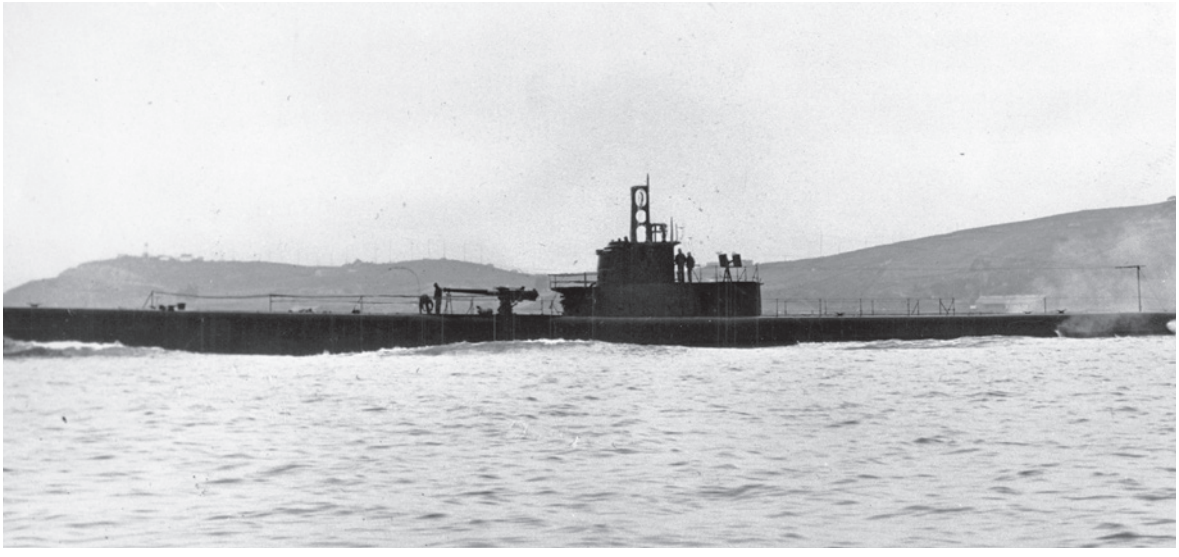




This is *Harder* in 1944. Note that the 5in./25 deck gun has been moved forward of the bridge. Skippers preferred this arrangement since it afforded them better control during a gunnery action. (Naval History and Heritage Command)

part of the war with a serious handicap. Under wartime conditions, these problems proved difficult to identify and fix. This was exacerbated by the secrecy attached to the magnetic exploder and the impulse by the bureaucracy responsible for their design to blame the submarine skippers and the personnel that maintained and prepared the torpedo. Not until September 1943 was the defective contact exploder fixed, the depth problem addressed, and the unreliable magnetic exploder inactivated.

Late in 1943, the electric Mark 18 torpedo entered service. This copy of a German torpedo possessed a top speed of 30kn, a 575lb warhead, and a maximum range of 4,000yd. By 1944, boats went to sea with a load of 75 percent Mark 18 torpedoes. The final torpedo to see service very late in the war was the Mark 23. It could be fired while submerged down to 150ft. Guidance was provided by a hydrophone mounted on the weapon that directed it toward the loudest noise. With a small 95lb warhead, it was useful for attacking and disabling enemy escorts.

On average, it took eight torpedoes to sink a ship in 1942, 11.7 in 1943, and ten in 1944. This increase may seem counterintuitive, but it should be kept in mind that later in the war skippers were firing full salvos at bigger and more valuable targets.

When the submarine skipper judged that a target was not worth a torpedo, or in dire situations of self defense, the deck gun was brought into play. Most USN submarines entered the war with a 3in./50 deck gun mounted aft of the conning tower. It fired a 13lb shell out to a range of just over 14,000yd. A handful of submarines carried larger deck guns. *Argonaut*, *Nautilus*, and *Narwhal* carried the largest deck gun on any USN submarine—two 6in./53 guns. *V-1* to *V-3* were initially fitted with 5in./51 guns. These were removed early in their careers and ended up on four Tambor-class units during the war. By June 1944, the 4in. gun was introduced. This gun could throw a 33lb projectile over 16,000yd. The preferred deck gun was the 5in./25. It used a 53lb projectile and possessed a maximum range of over 14,000yd. USN submarines were also fitted with a small number of antiaircraft guns to protect against limited air attack. Only .50-caliber and .30-caliber machine guns were initially fitted, but these quickly proved ineffective and were replaced with 20mm Oerlikon guns. In mid-1944,

a single-mount Bofors 40mm gun became available for submarines. Antiaircraft guns were much more commonly used to attack Japanese small craft rather than in their intended role. During the war, USN submarines made 939 gun attacks, in the course of which 722 vessels were sunk.

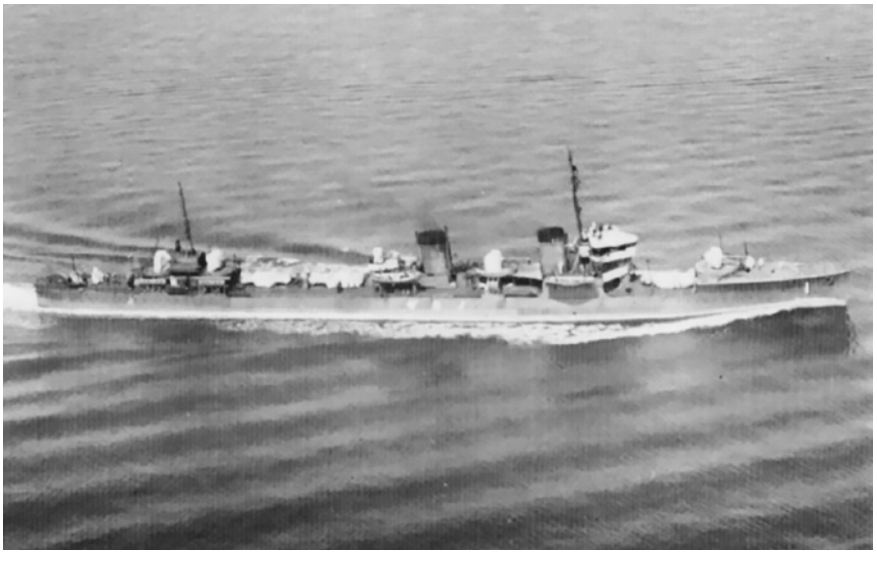
IJN ANTISUBMARINE ESCORTS

IJN FLEET DESTROYERS

ASW was not a high priority for the IJN at the start of the war. This prioritization was reflected in the allocation of destroyers to fleet support missions at the expense of defending trade. Designed as offensive platforms, fleet destroyers carried a powerful torpedo battery that allowed them to play their important role in a fleet action. Though these ships were superb torpedo boats, they possessed indifferent capabilities in other areas. As ASW platforms they had the benefit of high speed, decent range, and a powerful gun battery that could quickly overwhelm any surfaced submarine. They also carried the best IJN sonar available. A major weakness for ASW was their small depth-charge load. This prevented them from mounting a sustained attack on a submarine once it had submerged and the destroyer was uncertain of the submarine's exact location, meaning it was forced to saturate an area with depth charges in hope of gaining a hit. To address this weakness, the Japanese increased destroyer depth-charge loads as the war progressed.

The other weakness of IJN fleet destroyers was their lack of training in ASW tactics. Destroyers operated with the main fleet and training was focused on main fleet tactics, which for destroyers was torpedo attack. Little time was devoted to ASW training. This trend was exacerbated as the war developed and destroyer losses mounted and the remaining ships gained new missions, like supply runs. Losses and diversions to other missions meant that only a bare minimum was left for screening the main fleet. All of this meant it was increasingly rare to see a fleet destroyer on convoy escort duty.

Representative of the IJN's prewar fleet destroyers was Asashio-class *Yamagumo*. The ship is shown here running trials in 1939. IJN destroyers accounted for seven USN submarines. Among the destroyers to score a kill was *Yamagumo*. (Yamato Museum)



This is the Minekaze-class destroyer *Nokaze* in about 1928. Note the location of the four 4.7in. guns and the three torpedo mounts. By the start of the Pacific War, the Minekaze class was outdated and was relegated to escort duties. (Yamato Museum)

PREWAR IJN ASW ESCORTS

With fleet destroyers unable to contribute to trade protection, the initial burden of convoy escort duties fell to the IJN's oldest and second-line destroyers, augmented by a dozen torpedo boats that were no longer suited for fleet duties. These units included the 15 units of the Minekaze class completed between 1920 and 1922. Of these, two had been converted to patrol boats in 1939–40 with the deletion of much of their armament and two boilers in exchange for a larger depth-charge capacity and slower speed, but greater range. The nine destroyers of the Kamikaze class, completed between 1922 and 1925, were also reallocated to ASW duties.

Second-class destroyers of the Momi and Wakatake classes were dedicated to trade protection from the start of the war. The heavily armed (for its size) and fast (36kn) Momi class was commissioned between 1919 and 1922. Of the original 21 units, four had been retired, five converted into tenders, and nine converted into patrol boats,

Another group of IJN escorts comprised the Wakatake second-class destroyers. This is *Karukaya* in her original configuration in 1923. These ships proved ineffective as submarine hunters: they had no success against USN submarines, and lost four of their number to submarine attack. *Karukaya* escorted a record 54 convoys before her loss to two submarine-launched torpedoes on May 10, 1944. (Yamato Museum)

leaving only three destroyers still in service at the start of the war. The patrol boats were well suited for ASW duties since their depth-charge capacity had been increased to 60. The eight units of the Wakatake class were completed between 1922 and 1924 with a full load displacement of some 1,100 tons. Of the eight units completed, one had undergone conversion to a patrol ship with a depth-charge capacity of 60 by the start of the war; six remained in service as destroyers.

To avoid treaty restrictions in the 1930s, the Japanese tried to fit a near-destroyer armament suite on a hull of only 535 tons. Unsurprisingly, the result was a top-heavy disaster that required reconstruction after the lead ship capsized in 1934. From 1942, these torpedo boats were assigned to escort duties and proved to be good ASW escorts because of their combination of high speed, good handling, and adequate armament. They were considered to be dangerous opponents by USN submarine skippers. A dozen torpedo boats of the Tomozuru (four ships) and Otori (eight ships) classes were available at the start of the war.

IJN PURPOSE-BUILT ASW ESCORTS

Although Japan relied heavily on imports, the IJN possessed few purpose-built ASW escorts at the start of the war. Before the war, the IJN did consider building a large force of ASW escorts, but this plan was aborted because of budgetary reasons. The IJN was slow to adjust to the reality that a prolonged war made shipping protection a vital mission. When the magnitude of the threat to their shipping became fully apparent in 1943, the Japanese finally commenced mass production of ASW escorts. By the time large numbers of dedicated ASW escorts entered service in 1944, it was too late.

The first escorts (*kaibokan*) made up the Shimushu class, referred to by the IJN as Type A escorts. All four were commissioned in 1940 and 1941. The Shimushu class was originally designed for fishery protection and patrol duties in the Kurile Islands, further demonstrating what little regard the IJN had for shipping protection. All *kaibokan* were considered general-purpose escorts capable of minelaying, minesweeping, and ASW; convoy escort was originally the third priority for these

By the time the IJN got serious about building *kaibokan* in significant numbers, it was too late. This is *Ikuna*, an Ukuru-class unit, in October 1943 after her completion. *Ikuna* was part of a sub-class that used the armament and hull features of the Mikura class and all other features from the Ukuru class. Note the extensive depth-charge facilities on the stern. (Yamato Museum)

MIKURA-CLASS ESCORT

This is a Mikura-class escort in her original 1943 configuration. Early ships in the class possessed only two twin 25mm mounts abreast the bridge, but later in the war three triple mounts were placed on the aft deckhouse. Note the two depth-charge launchers aft and the retention of minesweeping gear. The ship has been completed with a Type 22 radar on the foremast.

ships. The Shimushu class was capable of operating in the rough waters of the North Pacific but was not a success in the ASW role. Weaknesses included a top speed inferior to that of a USN fleet submarine on the surface and a limited depth-charge capability.

As part of the naval build-up in the immediate prelude to war in 1941, the IJN decided to give more attention to convoy escorts. This included plans for 14 Modified Type A (Etorofu-class) and 16 Type B (Mikura-class) units. The fact that the Japanese thought that the provision of another 30 escorts to join the scant four escorts already in service would be sufficient is hard to understand, especially in light of the fight then ongoing in the Atlantic between German submarines and the Royal Navy. Equally mystifying are the characteristics of the Modified Type A escorts. Supposedly dedicated primarily to convoy escort, they carried only one depth-charge projector and retained the relatively low speed of the Shimushu class. The Modified Type A units entered service beginning in March 1943.

The Mikura class (Type B escort) was the first IJN ship maximized for ASW. Despite the fact it was based on the previous two classes of escorts, it was in some respects a whole new design. The original intent was to design a whole new hull, but to save time a simplified Etorofu hull was adopted. With an emphasis on ASW, the depth-charge capacity was augmented to bring it in line with the ships' primary mission. Construction of these ships began in October 1942.

By mid-1943, it was clear that the IJN had to devote more resources to ASW. This led to the design of the Modified Type B *kaibokan*. Beginning in January 1944, 31 units of the Ukuru class were laid down. The primary difference from the preceding class was an improved and simplified hull to facilitate mass production. Even though building time was reduced for the Mikura class, it was still too long in light of the pressing need for ASW escorts. Using the Mikura class as a basis, the new class was further simplified to allow for mass production. The hull form was altered by reducing the use of shaped steel and curved plate. This greatly saved construction time and though the new hull increased drag, there was no loss of speed. Curved plates on the bridge structure were also removed, and a hexagonal stack was provided in place of the previous round or oval stacks.

Even with the steps taken to simplify the Ukuru class for mass production, the Naval General Staff wanted an even more basic ASW escort that could be produced in even greater numbers. A smaller escort was needed to ease the congestion at larger shipyards, which were not able to meet the demands of escort production. A smaller and simpler escort design could be moved to small yards using prefabrication methods. These imperatives led to the development of the No. 1 Class *kaibokan* (Type C). The design process for the new class was shortened because of the worsening war situation. The Naval General Staff requirement was issued in March 1943, design work was completed in June, and the first ships were completed in February 1944. While smaller than previous escort classes, it still had to be capable of operations on the open sea. The basis for the design was the Sokuten-class minelayer that displaced 750 tons. To save construction time, electric welding was used to join the prefabricated sections. The main gun battery was reduced and the ship more sharply focused on ASW. Diesel engines were fitted that reduced the ship's top speed to an unsatisfactory 16.5kn.

TYPE D *KAIBOKAN*

This illustration shows a Type D *kaibokan* unit in late-war configuration. Armament includes two single 4.7in. guns, and an antiaircraft battery of 12 25mm guns in a mix of single, twin, and triple mounts. ASW weaponry has been emphasized with 12 depth-charge launchers aft. The ship carries a Type 22 radar on the foremast and a Type 13 on the mainmast.

Concurrent with the production of the Type C, construction also began on the No. 2 Class (Type D) *kaibokan*. These were virtually identical to the Type C but substituted turbine engines for the diesel engines, which were proving difficult to build in sufficient quantity. With the requirement for large numbers of escorts still paramount, and no other diesel engines available, the only solution was to fall back on turbine engines. These were much less fuel efficient than diesels, and thus provided shorter endurance.

This change in propulsion required a rework of the Type C design that was accomplished in just over a month from June to July 1943. The main difference was the larger fuel tanks on the Type D escorts that resulted in a slightly longer hull and deeper draft. Construction of Type D escorts began in October 1943; of the 143 ordered, only 63 were completed.

After an inexplicably slow start, the Japanese did complete a large number of dedicated ASW escorts. Of the 364 planned, 171 were completed. Another seven were finished after the war with American approval to carry out repatriation duties.

IJN ASW ESCORT WEAPONS AND SENSORS

Unless a submarine was caught on the surface, the only way to attack it was by using a depth charge. This was nothing more than an explosive-filled container that would detonate at a pre-set depth. IJN ASW ships had two methods of deploying depth charges. The most common way was by rolling them off racks on the stern. The second method was by projectors. There were two types of IJN depth-charge projectors. The Type 94 was a double-arm projector, fitted on the ship's centerline, which could throw weapons off either beam. The Type 81 projector was a single-arm projector fitted to throw weapons to only one side. When used with the Type 95 depth charge, the Type 94 could throw the weapon out to 245ft if fired on both sides or 345ft if fired from one. Once in the water, the depth charges sank to a pre-set depth and exploded. By their nature, depth charges were imprecise weapons; however, precision was essential since a charge had to explode within 20ft of a submarine to cause fatal damage and within 50–60ft to cause any damage.

A critical weakness of IJN early-war ASW efforts was the lack of a capable depth charge. The standard prewar weapon was the Type 95 depth charge. It contained a

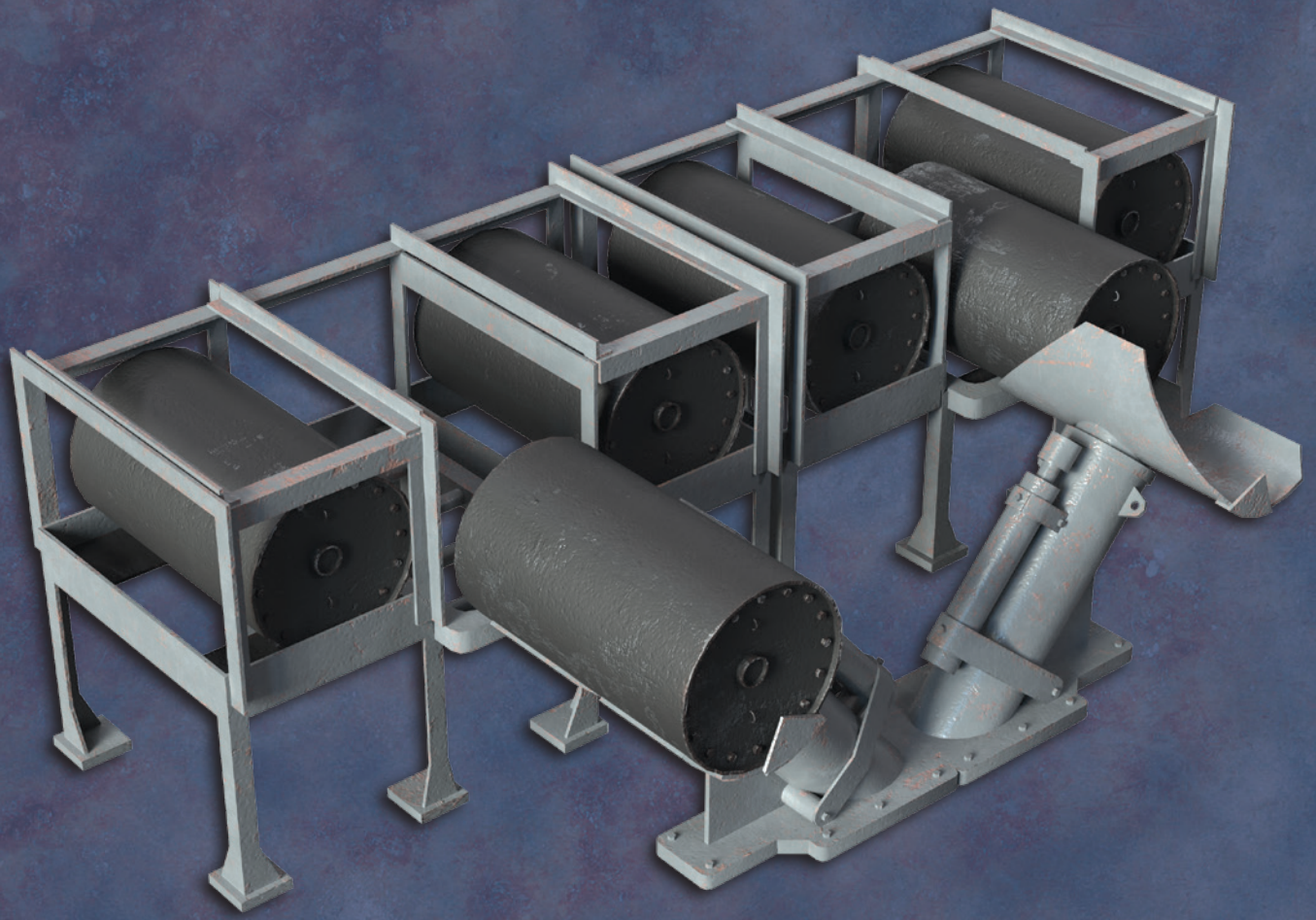
Table 1: IJN depth charges

	Type 95	Type 95 Mod 1	Type 95 Mod 2	Type 2	Type 2 Mod 1	Type 2 Mod 2
Adopted (year)	1937	1940	1942	1942	1942	1942
Explosive charge	220lb	330lb	242lb	220lb	330lb	242lb
Sinking velocity	6.2ft per second	8.5ft per second	6.6ft per second	6.2ft per second	8.9ft per second	6.6ft per second
Depth settings	98ft, 197ft, 295ft	98ft, 197ft, 295ft	98ft, 197ft, 295ft	98ft, 197ft, 295ft, 394ft, 492ft	98ft, 197ft, 295ft, 394ft, 492ft	98ft, 197ft, 295ft, 394ft, 492ft

IJN DEPTH CHARGES

The Type 94 depth-charge projector was standard aboard early-war IJN escorts. It could throw a single depth charge out to 345ft from the beam of an escort.

The standard IJN depth charge (shown loaded on the projector) at the start of the war was the Type 95. The weapon had a relatively small payload of 220lb and only three depth settings. Both would prove to be handicaps.



220lb charge, but had depth settings for only 98ft, 197ft, and 295ft. Since many USN submarines could dive deeper than 295ft, this was a critical weakness. American submarine skippers soon learned that if they went deep, a depth-charge attack might cause discomfort but not serious damage. The tactic of diving deep to avoid damage leaked out during the war in the American press, but there is no evidence that the Japanese picked up on this and modified their depth charges accordingly. However, by 1943–44, the Type 2 depth charge entered service. The newer weapon had additional settings for depths of 394ft and 492ft.

IJN *kaibokan* also carried an 80mm mortar forward of the bridge to engage submarines. This was the only weapon capable of engaging submerged targets ahead of the escort. Given its small shell, it was totally inadequate for its purpose. The lack of a forward-throwing ASW weapon on IJN escorts, like the USN's "Hedgehog," was a critical weakness since it meant that American submarines could only be engaged with projectors or stern racks that were released only after the escort closed on the submerged target and lost sonar contact (sonars of the period could not hold a contact located close to the ship).

If being saddled with inadequate weapons was not bad enough, IJN ASW escorts were equipped with mediocre sensors. Not all escorts even carried sonars; those that were well equipped carried both passive and active sensors. The passive sensor was the Type 93 hydrophone. It was adopted in 1935 and was equipped with 16 elliptical arrays. Sensitivity of the system was 35 decibels and range limited to 1,000yd under normal conditions. The active sonar came in two variants. The Type 93 entered service in 1933 for destroyers and was later fitted to most ASW escorts. The latest version was the Mod 3 that was deployed beginning in April 1942. It used a quartz projector for both transmission and reception. The system was capable of a maximum theoretical range of just over 6,500yd, but sonar ranges were affected by a number of environmental factors that usually decreased the system's effective range. Another factor affecting range was the speed of the ship using the sonar; because of the noise generated by water rushing along the ship's hull, the higher the speed the shorter the range. A wartime report from *kaibokan CD-22* reported that detection ranges against a submerged target moving at 7.5kn was 4,592yd if the ship's speed was 0kn, 3,280yd if the escort was moving at 12kn, and only 1,968yd if the ship was moving at 14kn. The Type 93 had a bearing accuracy of +3 degrees. In 1943, work began on a new sonar based on a German design. The Type 3 Mod 1 did not enter service until late 1944, when it became the standard sonar aboard escorts completed in the final months of the war. It exhibited the same detection ranges as the Type 93 but had better bearing accuracy. Compared to those of the other major navies of the period, the quality of IJN sonars was rudimentary.

The primary weapon aboard IJN ASW escorts for engaging surface targets was the 4.7in./45 3rd Year (1914) gun. It possessed a range of 17,500yd and fired a 45lb shell. It was adequate against surface targets but could not engage aerial targets. Fire control was provided by a bridge-mounted rangefinder; the IJN did not use radar for fire control. With two or three of these weapons, a *kaibokan* had the firepower to overwhelm a surfaced submarine. In any kind of gunnery engagement, a surfaced submarine was at a severe disadvantage. Any penetration of the submarine's pressure hull prevented the sub from diving, thus severely compromising its chances of survival.

THE STRATEGIC SITUATION

JAPANESE PERCEPTIONS

Shipping was the lifeblood of Japan's war planning and its economy. At the start of hostilities, Japan possessed 1,703 freighters and tankers larger than 500 tons. Among these were 94 tankers, which were key since Japan imported 82 percent of the oil she required. As war approached, the Imperial Army and Navy requisitioned some two-thirds of the total of approximately 6,000,000 tons of shipping. Of this total, the Imperial Army took about 2,200,000 tons and the Imperial Navy 1,900,000 tons, leaving the Ministry of Munitions with some 1,900,000 tons to service the civilian economy. The military was given the lion's share of shipping to carry out the planned invasions of Malaya, the NEI, the Philippines, and other places in Japan's initial war objectives. The share given to civilian needs was inadequate, but it was planned to return ships from military use before shipping shortages impacted the economy.

That proved impossible as the war developed. Shipping shortages at the start of the war only got worse as the Japanese had to move troops, supplies, and equipment around its newly expanded empire and then support those troops along the periphery of its defensive perimeter. Even in the early period of the war, the availability of shipping to move and support large forces was the critical limiting factor to operations. At the end of the period of expansion in mid-1942, Japanese shipping, and the means to defend them, was severely stretched. Forces in the

The IJN also had 27 submarine chasers in service before the war. These were useful for patrolling littoral waters, but were not usually used for convoy escort. The most numerous were the 15 units of the No. 13 class which displaced 460 tons and carried a large number of depth charges. This is *Submarine Chaser No. 25* in January 1942. The ship was sunk by USS *Grunion* off Kiska in July 1942. (Yamato Museum)

Central and South Pacific were supported by shipping from Truk. Forces in New Guinea were supported from Palau and from Rabaul. The critical shipping routes supporting the war economy stretched from Java and Sumatra in the NEI, up through the South China Sea, around Taiwan, and into the East China Sea and Japanese home waters.

The potential vulnerability of these shipping lanes and of shipping steaming throughout the Empire should have been obvious to the Japanese and a pressing wartime priority to defend. However, due to the IJN's basic wartime strategy and predilection for offensive warfare, very little thought had been devoted to studying how to defend Japan's sea lines of communication during wartime. Even fewer resources were allocated for this mission.

As was often the case in IJN strategic and operational planning, a set of optimistic assumptions, largely unsupported by fact, was used to wish away the problem of shipping defense. The primary assumption was that a decisive victory would be achieved, thus limiting the duration of the conflict. This not only explained why so few resources were allocated to the mission of shipping defense (which as a defensive activity did not offer the prospects of decisive victory), but also underwrote the low priority of ASW in general. Even with the scant resources devoted to shipping defense, Japanese prewar assumptions foresaw the loss of 800,000–1,100,000 tons of shipping in the first year of a war as Japanese ASW efforts were still developing. For the next two years, the loss of between 700,000 and 800,000 tons was assumed. If new construction and captured shipping were factored in, these losses would be entirely bearable.

Using available shipping as efficiently as possible took priority over defensive measures. This meant that most merchant ships, and even the precious tankers, proceeded independently. Ships were routed away from the known locations of submarines and used zigzagging, which USN submarine commanders assessed to be ineffective. At the approaches to major ports, local defense forces met the arriving merchantmen. Early in the war, convoys were only used along primary shipping routes. These were usually small, with only two to five merchant ships and a small escort, sometimes a single ship. The Japanese preferred to keep convoys as small as possible to maintain shipping efficiency. Convoy commanders also preferred small convoys. Convoys of more than three columns were hard to control because of untrained merchant crews and communications problems.

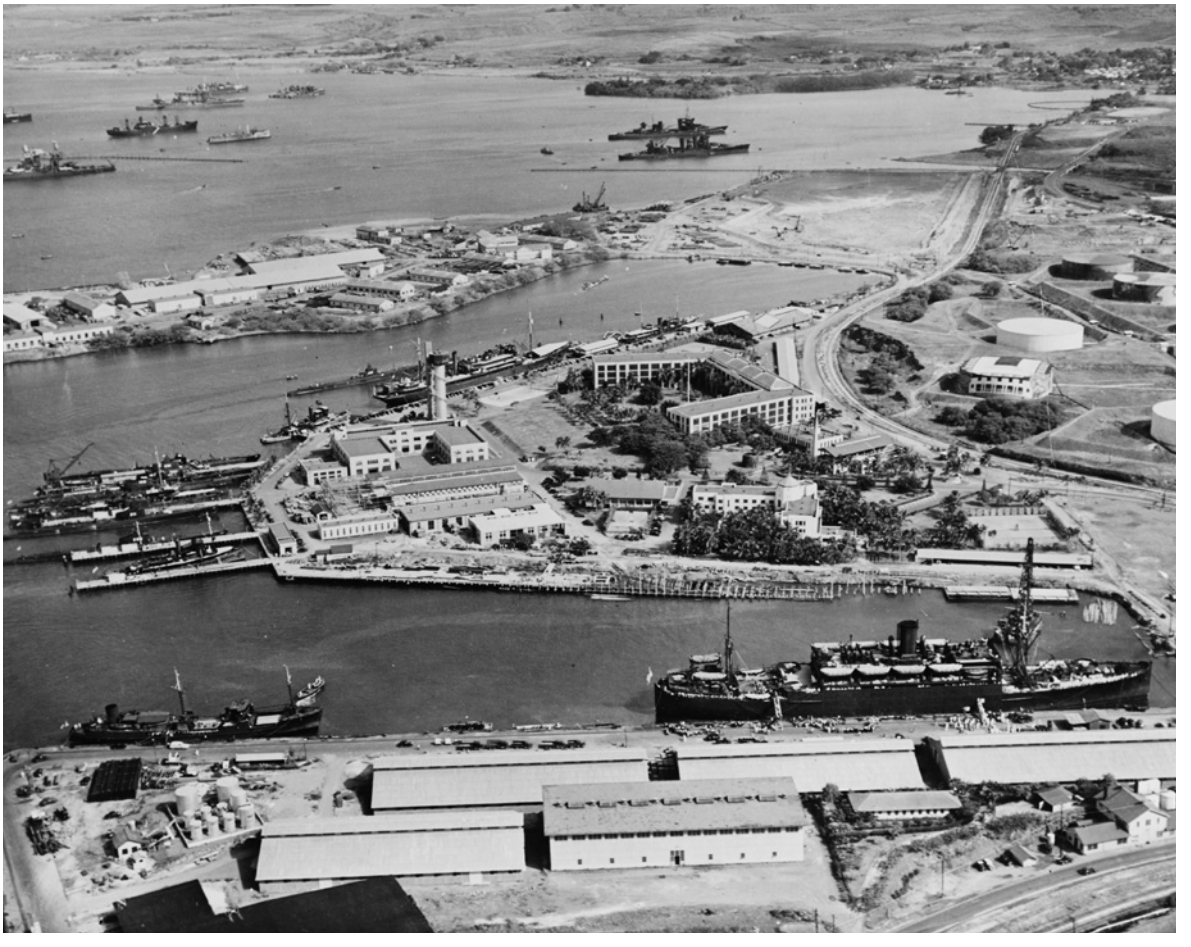
The IJN resisted the full institution of convoys until early 1944, when the full scope of the threat to shipping was evident and more escorts were available. By March 1944, larger convoys were being run with between 10 and 20 merchant ships and an escort of about five combatants. Later in the year, there were 15 captains and four rear admirals assigned to act as escort and convoy commanders for major convoys.

USN PERCEPTIONS

When hostilities commenced, the bulk of USN submarines in the Pacific were allocated to the Asiatic Fleet based in the Philippines. The principal mission of these 29 submarines was to protect the Philippines from invasion. In this, the submarine force failed miserably, neither stopping nor delaying the invasion, nor even exacting a heavy toll on Japanese shipping in the process. The same held true when the submarines were forced to retreat to bases in the NEI. Almost all these submarines survived the twin debacles of defending the Philippines and the NEI, and then fell back to a new base at Fremantle. From here, they fought a backwater war against Japanese shipping in Southeast Asia. Eventually, the strength of this force was increased to 30 boats as new boats rotated in from Pearl Harbor and boats patrolling from Fremantle went to Pearl Harbor and the West Coast for overhaul.

Throughout the war, the USN's most efficient submarines were those based at Pearl Harbor. On the very first day of the war, USN submarines were ordered to conduct unrestricted warfare against Japanese shipping. Submarines based in Hawaii initiated independent patrols. Of the nine boats at Pearl Harbor at the start of the war, seven were quickly readied for war patrols. Four were dispatched to the Marshall Islands to determine whether a major Japanese operation was being prepared there, and the other three were sent to attack shipping off the east coast of Japan.

The early strategy of unrestricted submarine warfare against Japanese shipping provided promising results. Japanese ASW defenses were reported by skippers returning from early patrols as meager, but torpedo problems and timid tactics curtailed early USN submarine successes. As 1941 turned into 1942, the submarine force picked up several new missions that disrupted any concerted



This is an aerial view of the Submarine Base at Pearl Harbor taken October 13, 1941. It was the USN's most important submarine base during the war. The building beside the submarine escape tower housed the US Fleet Headquarters on December 7, 1941. Six submarines can be seen in this view: *Tuna*, *Gudgeon*, *Argonaut*, *Narwhal*, *Triton*, and *Dolphin*. (Naval History and Heritage Command)

attack on Japanese shipping. Submarine operations in 1942 were marked with frustrations as large numbers of patrols were conducted in defense of Midway in June and in the second half of the year against the heavily patrolled waters off Truk Atoll, the principal IJN base in the Central Pacific. From August, the USN focused on the campaign to take and hold Guadalcanal in the southern Solomon Islands, but USN submarine commanders were slow to shift forces in support of the campaign. When they did, submarine operations in the South Pacific were largely ineffective.

During 1942, 37 submarines joined the Pacific Fleet, bringing its strength up to 80 boats at the beginning of 1943. These were increasingly employed against shipping in the waters off Japan and in the East China Sea, which had always been the most profitable patrols from the earliest days of the war. Total Japanese shipping losses in 1943 were not crippling, but the stage was set for a full-scale massacre in 1944.

TECHNICAL SPECIFICATIONS

USN SUBMARINES

THE V-BOATS

The first three, commissioned between 1924 and 1926, were not successful. *V-4*, renamed *Argonaut*, was the largest of the V-boats and the only USN submarine designed as a minelayer. She and the three previous boats carried the largest deck guns on any USN submarine—two 6in./53 single guns. Able to carry 16 torpedoes, later increased to 20, with four (later increased to six in 1942) torpedo tubes, she remained useful, but was too unwieldy for patrol duties. She was converted to a transport submarine able to carry 120 Marines and was employed successfully in that role.

Argonaut (originally *V-4*) was the USN's only submarine minelayer. Unsuccessful in this role, she was converted into a transport submarine and served in that role during the war. Here she is shown docking at Pearl Harbor upon her return from the Makin raid, August 26, 1942. Despite her size, which made her unwieldy and slow to dive, *Argonaut* was foolishly employed on a regular war patrol. While attacking a convoy headed for Rabaul on January 10, 1943, she was sunk by IJN fleet destroyers. (Naval History and Heritage Command)

Table 2: *V-4* specifications (as built)	
Displacement	Standard 2,710 tons; submerged 4,164 tons
Dimensions	Length 381ft; beam 33ft 10in.
Propulsion	Two diesel engines generating 3,175 shp for a maximum surface speed of 13.65kn; submerged speed 7.43kn
Operating depth	300ft
Range	18,000NM at 10kn; patrol endurance 90 days
Crew	86

Narwhal (formerly *V-5*) was the non-minelayer version of the USN's cruiser submarines. Here she is photographed at the Mare Island Navy Yard on March 28, 1943 (the areas outlined in white indicate recent alterations). Note the 6in./53 deck guns, the largest ever carried on a USN submarine. *Narwhal* assembled a fine war record. She conducted 15 patrols, 12 of which were special missions moving men and equipment behind Japanese lines, and sank seven Japanese ships. (Naval History and Heritage Command)

V-5 and *V-6*, later renamed *Narwhal* and *Nautilus*, were essentially repeats of *V-4* but without the minelaying equipment. Instead, the boats carried a heavy torpedo battery of four bow and two stern tubes with a large torpedo load of up to 38–40 torpedoes (24–26 internal and another 12–16 stored externally). Their size made them slow to dive and easy to spot both on the surface and at shallow depths. Early in the war, both were modernized with more reliable diesel engines and four external torpedo tubes. Both conducted special missions after being converted to transport submarines.

Table 3: *V-5* specifications (as built)	
Displacement	Standard 2,730 tons; submerged 4,040 tons
Dimensions	Length 370ft 7in.; beam 33ft 3in.
Propulsion	Two diesel engines generating 5,633 shp for a maximum surface speed of 17.44kn; submerged speed 8kn
Operating depth	300ft
Range	18,000NM at 10kn; patrol endurance 90 days
Crew	89

V-7 (later *Dolphin*) represented the USN's move away from large and expensive cruiser-type submarines. The boat was equipped with six torpedo tubes—four bow and two stern—and had a torpedo capacity of 18 internal and three more external. Top speed was 17kn with German-designed diesels.

Table 4: *V-7* specifications (as built)	
Displacement	Standard 1,560 tons; submerged 2,240 tons
Dimensions	Length 319ft 3in.; beam 27ft 11in.
Propulsion	Four diesel engines (two main and two generator) generating 4,086 shp for a maximum surface speed of 17.3kn; submerged speed 8kn
Operating depth	250ft
Range	6,000NM at 10kn; patrol endurance 75 days
Crew	63

The final two V-class boats (later named *Cachalot* and *Cuttlefish*) continued the trend to smaller fleet boats. Both were based on a German World War I design and featured savings in weight and space made possible by a new type of German-designed diesel engine. *Cuttlefish* was built by the Electric Boat Company in Groton, Connecticut; it featured improvements to the boat's internal arrangements, and was the first to make significant use of welding for the hull. *Cuttlefish* also received air conditioning and was the first boat fitted with the Mark I Torpedo Data Computer. Even with these advanced features, the boats were not considered a success.

Cuttlefish was a return to a medium-size submarine that proved a false step for American submarine designers. This is *Cuttlefish* off the Philadelphia Navy Yard on November 15, 1943, by which time she had been assigned to training duties after a short combat career of four patrols with no confirmed sinkings. (Naval History and Heritage Command)

Table 5: *V-8* specifications (as built)	
Displacement	Standard 1,130 tons; submerged 1,650 tons
Dimensions	Length 271ft 11in.; beam 24ft 11in. (*V-8* 274ft; beam 24ft 9in.)
Propulsion	Two diesel engines generating 3,070 shp for a maximum surface speed of 16.5kn; submerged speed 8kn
Operating depth	250ft
Range	11,000NM at 10kn; patrol endurance 75 days
Crew	45

BOATS OF THE 1930S

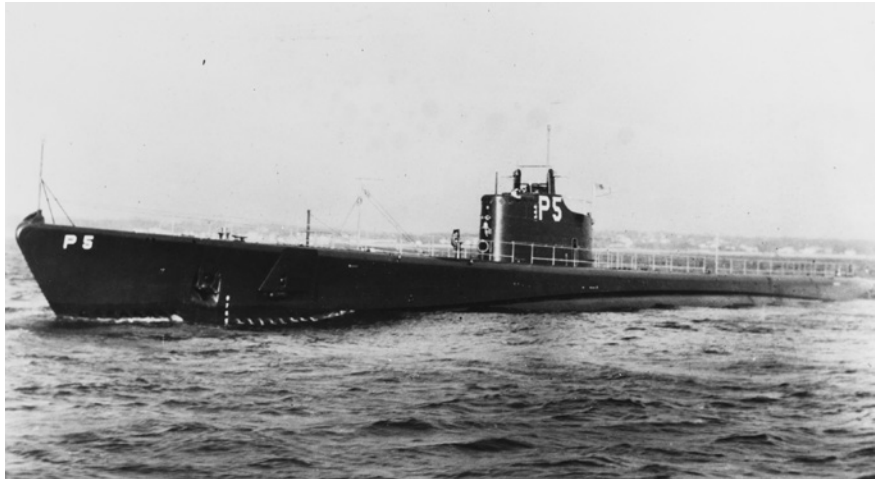
The two-boat Porpoise class was built by Portsmouth Navy Yard as an improved *Cachalot*. The boats were not considered a success with their riveted hulls, old-style berthing and messing arrangements, mediocre endurance, and unreliable all-electric propulsion plants.

Table 6: *Porpoise* specifications (as built)	
Displacement	Standard 1,310 tons; submerged 1,934 tons
Dimensions	Length 301ft; beam 24ft 11in.
Propulsion	Four main generator engines generating 4,300 shp for a maximum surface speed of 18.8kn; submerged speed 8kn
Operating depth	250ft
Range	11,000NM at 10kn; patrol endurance 75 days
Crew	50 (1944)

The two boats of the Porpoise class were the first in a series of fleet boats built in the 1930s. The design was not successful. *Porpoise* conducted six patrols before being assigned to training duties after July 1943. This is *Porpoise* off the Mare Island Navy Yard on October 13, 1942. (Naval History and Heritage Command)

Shark nearly ready for launching at the Electric Boat Company shipyard at Groton, Connecticut on May 20, 1935. Note the four bow torpedo tubes. Later submarines were fitted with six bow tubes in response to submarine skippers' demands for increased firepower. *Shark* was the first submarine lost to IJN surface ships, on February 11, 1942. (Naval History and Heritage Command)

A sub-class consisted of the two Shark-class units (*Shark* and *Tarpon*) built by Electric Boat. In terms of armament, they were identical to the Porpoise class (six tubes—four bow and two stern—with a capacity of 16 torpedoes). The propulsion system used was the same one on the Porpoise class in which high-speed electric motors powered the engines through reduction gears. They were the USN's first all-welded submarines. An all-welded hull increased underwater survivability.



Perch photographed off Groton at the time of her completion in late 1936. Note the original size of the sail and that the 4in. deck gun has not yet been fitted. On her second patrol, during which she failed to score a victory, *Perch* was sunk on March 3, 1942. (Naval History and Heritage Command)

Table 7: *Shark* specifications (as built)	
Displacement	Standard 1,316 tons; submerged 1,968 tons
Dimensions	Length 298ft 1in.; beam 25ft 1in.
Propulsion	Four main generator engines making 4,300 shp for a maximum surface speed of 19.5kn; submerged speed 8kn
Operating depth	250ft
Range	11,000NM at 10kn; patrol endurance 75 days
Crew	50

The Shark class was a clear success and provided the basis for six nearly identical Perch-class boats. Their engine rooms were lengthened 2ft to improve access to the machinery. The armament fit was unchanged.

Table 8: *Perch* specifications (as built)	
Displacement	Standard 1,335 tons; submerged 1,997 tons
Dimensions	Length 300ft 7in.; beam 25ft 1in.
Propulsion	Four main generator engines making 4,300 shp for a maximum surface speed of 20.1kn; submerged speed 8kn
Operating depth	250ft
Range	11,000NM at 10kn; patrol endurance 75 days
Crew	50

The Salmon class of six units became the USN's preferred fleet boat design and provided the template for future construction. The torpedo battery was increased to eight tubes—four each in the bow and stern. Torpedo capacity increased to 20, all carried internally. A new propulsion system increased top surface speed to over 21kn.

Table 9: *Salmon* specifications (as built)	
Displacement	Standard 1,449 tons; submerged 2,210 tons
Dimensions	Length 308ft; beam 26ft 2in.
Propulsion	Two main and two generator engines making 5,500 shp for a maximum surface speed of 21.4kn; submerged speed 9kn
Operating depth	250ft
Range	11,000NM at 10kn; patrol endurance 75 days
Crew	55

Salmon photographed off the Mare Island Navy Yard on August 10, 1944 before the last of her 11 patrols. During this period she had minimal success, sinking only four ships and gaining shared credit for a fifth. (Naval History and Heritage Command)

The six units of the Sargo class were virtual repeats of the previous class. They carried the same armament and the same propulsion system. Among the refinements introduced were a new higher-capacity battery, two extra feet in length to reduce engine room crowding, and other internal alterations.

Sargo, lead ship of her class, photographed off Provincetown, Massachusetts, during trials on November 1, 1938. The boat had a successful wartime career, conducting 12 patrols and sinking seven confirmed Japanese ships. (Naval History and Heritage Command)

Table 10: *Sargo* specifications (as built)	
Displacement	Standard 1,460 tons; submerged 2,350 tons
Dimensions	Length 310ft 6in.; beam 27ft 1in.
Propulsion	Two main and two generator engines making 5,500 shp for a maximum surface speed of 20.6kn; submerged speed 8.75kn
Operating depth	250ft
Range	11,000NM at 10kn; patrol endurance 75 days
Crew	55

The four boats of the Seadragon class were identical to the previous class in size and capabilities, but reverted to an all-electric drive.

Table 11: *Seadragon* specifications (as built)	
Displacement	Standard 1,450 tons; submerged 2,350 tons
Dimensions	Length 310ft 6in.; beam 27ft 1in.
Propulsion	Four main generator engines making 5,200 shp for a maximum surface speed of 20kn; submerged speed 8.75kn
Operating depth	250ft
Range	11,000NM at 10kn; patrol endurance 75 days
Crew	55

Tambor pictured on April 2, 1945 in her final configuration. Note the 5in./25 deck gun aft. The boat sank 12 Japanese ships during her 12 patrols, before being retired from combat duties in November 1944. (Naval History and Heritage Command)

The 12 boats of the Tambor class represented the final peacetime refinement on the fleet boat design before mass wartime production. In response to requests from submarine commanders, the number of bow tubes was increased to six, all internal; four tubes remained on the stern. Torpedo capacity was increased to 24. Offensive punch was also increased with the provision of the heavier 5in./51 deck gun on some boats to replace the usual 3in./50 gun decried by submarine commanders as inadequate. Other features directly affecting combat performance included a new type of periscope, and improved sonar and fire control equipment. The hull was simplified to make construction easier and faster. In addition to their offensive capabilities, the boats had features that enhanced habitability like air conditioning, fresh-water distillers, and improved messing and sleeping facilities. The Tambor class was the best submarine in the world when it entered service.

Table 12: *Tambor* specifications (as built)	
Displacement	Standard 1,475 tons; submerged 2,370 tons
Dimensions	Length 307ft 3in.; beam 27ft 3in.
Propulsion	Four main generator engines making 5,400 shp for a maximum surface speed of 20kn; submerged speed 8.75kn
Operating depth	250ft
Range	11,000NM at 10kn; patrol endurance 75 days
Crew	60

WAR-BUILT BOATS

The Gato class was the first mass-produced fleet boat. The first arrived in the Pacific in mid-1942. Only evolutionary modifications were made to these boats during the war, which was a testimony to the excellence of the basic design. To decrease diving time and permit the placement of 20mm and later 40mm guns, the conning tower was modified. The original 3in./50 deck gun was replaced by 4in. or 5in./25 guns. These boats formed the backbone of USN wartime submarine operations in the

Gato, lead ship in the USN's most important class of Pacific War submarines, photographed being launched at the Electric Boat Company at Groton on August 21, 1941. She had a successful wartime career, with ten Japanese ships sunk, including *kaibokan CD-9*, over the course of 13 patrols. (Naval History and Heritage Command)

Pacific—the highest number available was 64 in 1944. In total, Gato-class boats made 587 of the 1,635 Pacific war patrols (34 percent).

Table 13: *Gato* specifications (as built)	
Displacement	Standard 1,526 tons; submerged 2,424 tons
Dimensions	Length 311ft 9in.; beam 27ft 3in.
Propulsion	Four main generator engines making 5,400 shp for a maximum surface speed of 20.25kn; submerged speed 8.75kn
Operating depth	300ft
Range	11,000NM at 10kn; patrol endurance 75 days
Crew	60 (wartime 81)

The largest-ever class of USN submarines was the Balao class, with 119 built. These boats were virtually identical to the preceding Gato class, both externally and internally. The use of high-tensile steel on the hulls increased their operating depth to 400ft, which was a significant tactical advantage. Another enhancement halfway

Balao, lead ship of the USN's most numerous class of submarines, returns to port after a 1945 patrol, probably at Guam. Note her 5in./25 deck gun at right, battle flag hung from her forward 20mm gun, and blindfolded Japanese prisoners of war being escorted on deck. *Balao* sank six Japanese ships in ten patrols. (Naval History and Heritage Command)

Tench-class boat *Torsk* photographed on February 16, 1945. Like most ships in her class, she began patrols too late in the war to find many targets. Nevertheless, on her second patrol in the Sea of Japan she sank a small freighter followed by *CD-13* and *CD-47* on July 14, 1945. These were the last ships sunk by USN submarines during the war. (Naval History and Heritage Command)

through the Balao construction program was an improvement in torpedo storage that brought total capacity to 28 weapons.

Table 14: *Balao* specifications (as built)	
Displacement	Standard 1,525 tons; submerged 2,415 tons
Dimensions	Length 311ft 9in.; beam 27ft 3in.
Propulsion	Four main generator engines making 5,400 shp for a maximum surface speed of 20.25kn; submerged speed 8.75kn
Operating depth	400ft
Range	11,000NM at 10kn; patrol endurance 75 days
Crew	81

The Tench class was the final refinement of the fleet boat. Only 25 were finished, despite the initial authorization of 147. Externally they were indistinguishable from the late Gato-class or Balao-class boats. Survivability was enhanced by internal differences to reduce the vulnerability to flooding and new low-speed electric motors to reduce noise.

Table 15: Tench-class specifications (as built)	
Displacement	Standard 1,570 tons; submerged 2,415 tons
Dimensions	Length 311ft 8in.; beam 27ft 3in.
Propulsion	Diesel-electric direct drive with four main generator engines making 5,400 shp for a maximum surface speed of 20.25kn; submerged speed 8.75kn
Operating depth	400ft
Range	11,000NM at 10kn; patrol endurance 75 days
Crew	81

Most of the remaining units of the Momi class were converted to patrol boats before the war. With their increased depth-charge load of up to 48 and four depth-charge projectors, they were well suited for convoy escort. This is *Patrol Boat No. 35* (formerly *Tsuta*) after conversion. (Yamato Museum)

IJN ANTISUBMARINE ESCORTS

MOMI CLASS

These ships were typed as second-class destroyers primarily designed for operations in littoral waters. A total of 21 were built between 1920 and 1922. The concept of the second-class destroyer fell out of favor when it became apparent that fleet destroyers offered much more capability.

These ships were reaching the end of their service lives when the Pacific War commenced.

The original armament of the class was three 4.7in./45 single guns, two twin 21in. torpedo mounts, and two 7.7mm machine guns for antiaircraft protection. These were the first IJN second-class destroyers fitted with 21in. torpedo tubes. During the war, the ASW and antiaircraft capabilities of the three remaining destroyers were upgraded. The minesweeping equipment on the stern was removed to allow the addition of four depth-charge launchers. The depth-charge capacity was increased to 36–48.

The best ASW ships of the class were the nine ships converted to patrol boats in 1940. These had one boiler removed, cutting the ships' maximum speed to 18kn. The armament was altered by the removal of both torpedo mounts and the amidships 4.7in. gun. The minesweeping gear aft was exchanged for three depth-charge launchers and magazine capacity for 36 depth charges was created. During the war, some ships had their depth-charge capacity increased to 60.

Table 16: Momi-class specifications (as modified to patrol boats)

Displacement	935 tons standard displacement, 1,162 tons full load
Dimensions	Length 275ft; beam 26ft; draft 8ft
Speed	18kn
Range	Unknown
Crew	110 (as destroyers)

WAKATAKE CLASS

The last IJN second-class destroyers built were the Wakatake class. Of the 13 planned, only eight were completed. Original armament was identical to the Momi class, and the ships' wartime modifications were also similar to those on the Momi class. The minesweeping equipment was removed in favor of four depth-charge launchers and storage for 36–48 depth charges. One of the 4.7in. guns was removed and replaced with two triple 25mm guns. At least one ship had one of her torpedo mounts removed; all ships were equipped with additional 25mm guns as the war progressed and some were fitted with radar. One Wakatake-class ship was converted to a patrol boat before the war.

Table 17: Wakatake-class specifications (as completed)	
Displacement	900 tons standard displacement, 1,100 tons full load
Dimensions	Length 275ft waterline; beam 26ft 7in.; draft 8ft 3in.
Speed	35.5kn
Range	3,000NM at 15kn
Crew	110

TOMOZURU CLASS

Following the reconstruction of the four ships of this class, all mounted three 4.7in. guns in single mounts. One of the two original twin 21in. torpedo mounts was retained. For ASW work, one Type 94 depth-charge launcher was fitted. Later in the war, the class had one 4.7in. gun removed while retaining the twin torpedo mount. ASW capability was significantly increased in keeping with the ships' new primary mission. Depth-charge capacity was increased to 48. The weapons were deployed by two stern racks and eight Type 81 depth-charge launchers on the stern.

Table 18: Tomozuru-class specifications (after reconstruction)	
Displacement	600 tons standard displacement; 815 tons full load
Dimensions	Length 269ft overall; beam 24ft 3in.; draft 8ft 2in.
Speed	28kn
Range	1,600NM at 14kn
Crew	113 (as built)

OTORI CLASS

The eight ships of this class incorporated the modifications made on the Tomozuru class, but on a slightly larger and beamier hull. More powerful machinery resulted in a maximum speed of 30kn. Armament was similar with three single 4.7in. guns; these had an increased elevation that allowed them to engage aircraft. A triple 21in. torpedo

Built to act as small destroyers, the Chidori-class torpedo boats turned into excellent ASW ships by virtue of their high speed, good acceleration and handling, and heavy depth-charge fit later in the war. This is *Manazuru* in 1934. (Yamato Museum)

mount was fitted and a single 40mm gun provided for antiaircraft protection. A single Type 94 depth-charge launcher was fitted for ASW work. By 1944, the aftermost 4.7in. gun was removed and the antiaircraft fit increased to 11 25mm guns. The ASW battery was expanded to two stern racks and six Type 81 launchers with a depth-charge capacity of 48. Some ships were equipped with radar.

Table 19: Otori-class specifications

Displacement	960 tons standard displacement; 1,040 tons full load
Dimensions	Length 272ft 4in. overall; beam 26ft 10in.; draft 9ft
Speed	30.5kn
Range	4,000NM at 14kn
Crew	113 (as built)

SHIMUSHU CLASS

The origin of the four-ship Shimushu class was an attempt by the IJN to build ships of 1,200 tons armed with four 5in. dual-purpose guns to exploit a loophole in the London Naval Treaty of 1930. Because of a lack of funds, the first *kaibokan* was not approved until 1937. By this time, the design had changed to a smaller ship of 860 tons armed with three 4.7in. low-angle guns from old destroyers.

The design was more complex than the IJN preferred, but was still approved. This seemingly unimportant development on a low-priority program ended up being unfortunate in the long term. The Shimushu class became the template for future *kaibokan* construction, but the complex design included aspects for which prefabrication was not possible, which increased building times.

The first *kaibokan* was the four-ship Shimushu class. This is the lead ship of the class in June 1940 on sea trials. Though poorly designed for ASW, *Ishigaki* did account for *S-44*, but was later sunk by *Herring* on May 31, 1944. *Shimushu* was also torpedoed, by *Haddo*, but survived. (Yamato Museum)

When completed, the ships' main battery consisted of three 4.7in. single guns that were only capable of engaging surface targets. Two twin 25mm mounts provided antiaircraft protection. One depth-charge launcher was fitted, and 18 Type 95 depth charges carried. The ships did not carry hydrophones or sonar. In 1942, Type 93 sonar was installed and the depth-charge capacity increased to 36; this was further increased to 60 in 1943. An 80mm ASW mortar was also added. By 1944, all ships had received radar and the 25mm fit was increased to five triple mounts.

Table 20: Shimushu-class specifications

Displacement	860 tons standard displacement; 1,020 tons full load displacement
Dimensions	Length 255ft 11in. overall; beam 29ft 10in.; draft 10ft
Speed	19.7kn
Range	8,000NM at 16kn
Crew	147

ETOROFU CLASS

When the IJN decided to build more *kaibokan*, the Shimushu class was used as the design basis with only slight modifications. Production of the 14 ships in the class began in February 1942. Despite attempts to simplify the hull and superstructure, the design was still too complex for easy mass production. Only one Model 94 depth-charge launcher was fitted on the quarterdeck, but depth-charge capacity was increased to 36. As construction of the class progressed, later ships had a depth-charge capacity of 60 by removing the two paravanes. All ships carried a Model 93 sonar and a Model 93 hydrophone when completed. Wartime modifications included the provision of radar, an 80mm ASW mortar, and a greatly expanded light antiaircraft gun suite of 25mm mounts.

The Etorofu class was a simplified version of the Shimushu class. This is *Amakusa* in November 1943 immediately after her completion. Note the simplified bow, stern, and superstructure. (Yamato Museum)

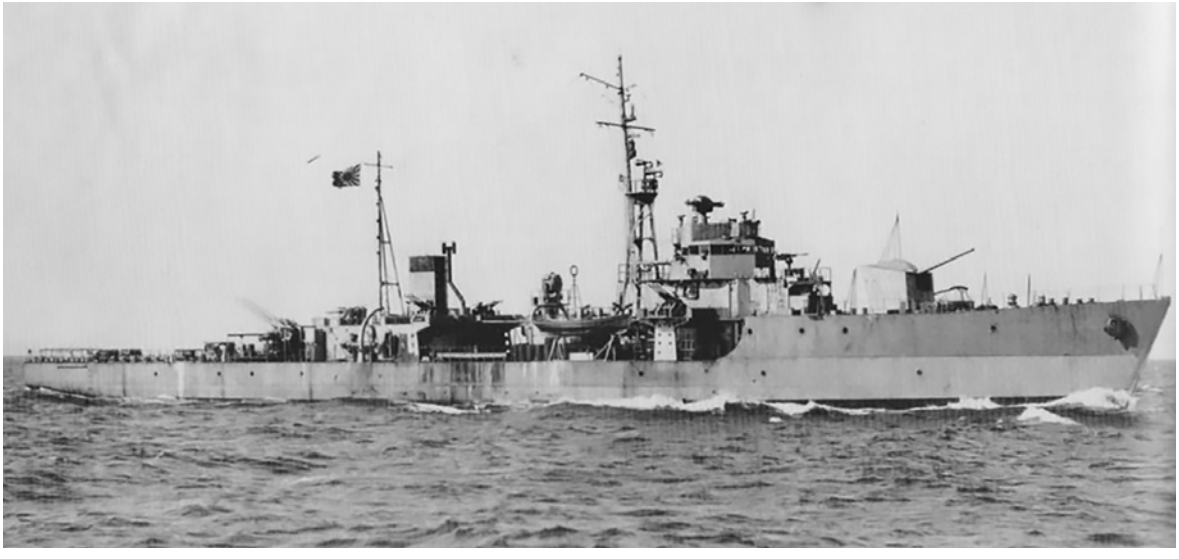
Table 21: Etorofu-class specifications	
Displacement	870 tons standard displacement
Dimensions	Length 255ft 11in. overall; beam 29ft 10in.; draft 10ft
Speed	19.7kn
Range	8,000NM at 16kn
Crew	147

MIKURA CLASS

The eight ships built to this design reflected an emphasis on ASW for the first time. These ships were simplified from earlier *kaibokan* with the result that building time was reduced 20 percent, but production times were still too lengthy. The Mikura class retained two diesels, which provided great range, but a greater displacement slightly reduced maximum speed. Range for the class dropped to 5,000NM because less fuel was carried.

The main gun was altered to the 4.7in./45 dual-purpose gun, and two twin 25mm mounts were fitted for antiaircraft protection. ASW capabilities were significantly increased. Two Model 94 depth-charge launchers were fitted, and depth-charge capacity increased to 120 Type 95 depth charges. A Model 93 sonar and a Model 93 hydrophone were aboard when completed. The class received the upgraded Model 3 Type 2 sonar in early 1944. A third Type 94 depth-charge launcher was later added. Other wartime modifications included the addition of 10–17 additional 25mm mounts, two types of radar, and an 80mm mortar.

Table 22: Mikura-class specifications	
Displacement	1,020 tons standard displacement
Dimensions	Length 258ft 6in. overall; beam 29ft 10in.; draft 10ft
Speed	19.5kn
Range	5,000NM at 16kn
Crew	150



Amani, an Ukuru-class unit, was not completed until May 1945 (the date of this photograph), and thus entered service much too late to have an impact. Note the depth-charge projectors on the stern. (Yamato Museum)

UKURU CLASS

By late 1943, when the first of 29 Ukuru-class units was laid down, it was essential that the new class be further simplified so that large numbers could quickly enter service. Building time was reduced to only four months in some yards by simplifying the hull and using modular construction. ASW weapons included capacity for 120 depth charges. Nine ships were fitted with three Model 94 depth-charge launchers and two depth-charge rails on the stern. The remainder received 16 Model 3 depth-charge launchers arranged eight to a side on the ships' sterns. All ships were provided with a Model 93 sonar and a Model 93 hydrophone; selected units later received the Type 3 Model 2 sonar.

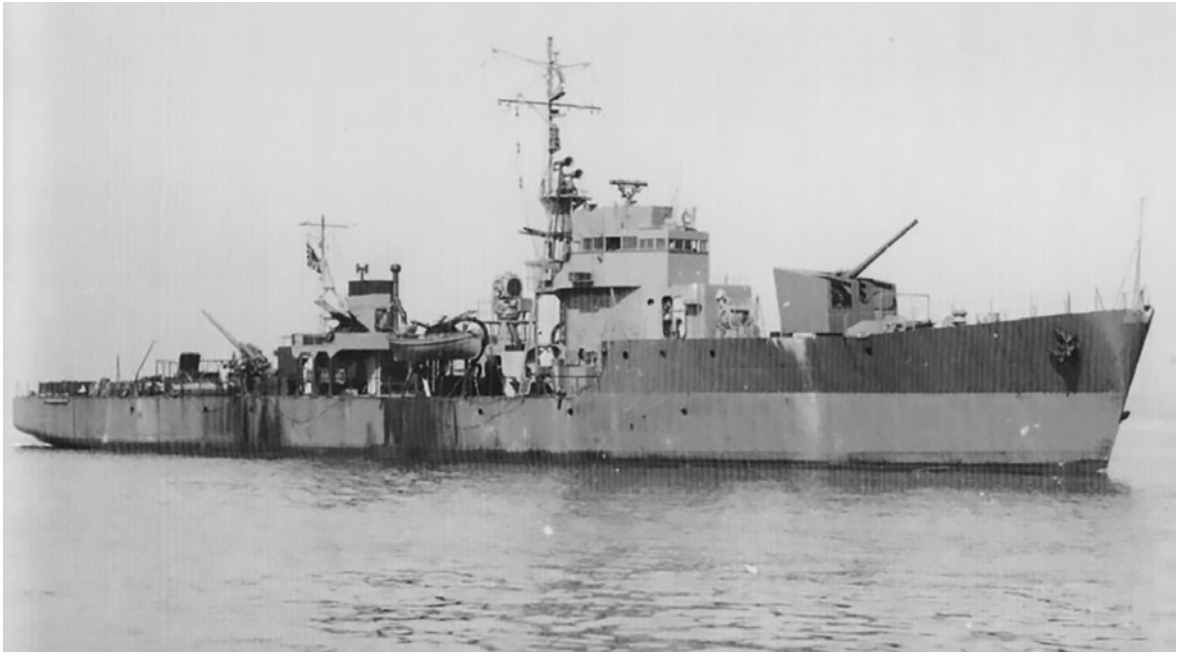
Completed late in the war, Ukuru-class units received the upgrades to earlier *kaibokan*. Modified gun shields were fitted to the dual-purpose 4.7in./45 mounts on later ships. Antiaircraft weaponry was increased to as many as 20 25mm guns in triple and single mounts. Two kinds of radar were fitted.

Table 23: Ukuru-class specifications

Displacement	940 tons standard displacement
Dimensions	Length 258ft 5in. overall; beam 29ft 10in.; draft 10ft
Speed	19.5kn
Range	5,000NM at 16kn
Crew	150 (as designed), rising to 225

NO. 1 CLASS ESCORT (TYPE C)

Not until March 1943 did the IJN get really serious about ASW escort production. The result was a smaller, even more austere ship called the No. 1 Class Escort (Type C). To save construction time, electric welding was used to join the prefabricated sections.



CD-17 was a No. 1 Class *kaibokan* completed in April 1944. This is the ship on acceptance trials. *CD-17* projects an austere appearance. Though suited for mass production, these ships were slow, cramped, and not well armed. (Yamato Museum)

Some yards completed Type C escorts in four months. A total of 132 Type C units were planned, but only 53 were finished by war's end.

The design was far from perfect. The ship was small and cramped; crew habitability was poor. Antiaircraft protection was weak. Most importantly, the single type of diesel engine suitable for mass production gave a maximum speed of only 16.5kn, lower than any other escort class and some four knots slower than a surfaced USN fleet submarine. The propulsion system produced excessive vibration and engine noise that affected the performance of the ship's sonars and hydrophones.

The ASW fit included capacity for 120 depth charges. These were launched by 12 Model 3 depth-charge launchers (six on each beam). To engage target ahead, an 80mm ASW mortar was placed in front of the bridge. ASW sensors included two Type 3 Model 2 sonars and a Type 93 hydrophone.

The main gun battery consisted of two single dual-purpose 4.7in./45 mounts. Antiaircraft protection was originally limited to only two triple 25mm mounts; this was later augmented with another two triple and two single mounts. Type C escorts carried the typical *kaibokan* radar fit of two different types of radar.

Table 24: No. 1 Class (Type C) specifications

Displacement	745 tons standard displacement; 810 tons trial displacement
Dimensions	Length 221ft 6in. overall; beam 27ft 7in.; draft 9ft 6in.
Speed	16.5kn
Range	6,500NM at 14kn
Crew	125 (design); rising to 170

NO. 2 ESCORT CLASS (TYPE D)

Production of Type C units was restricted by the available supply of diesel engines. To solve this problem, the IJN was forced to resort to turbines. For an ASW escort this was not ideal, since turbines were not as efficient as diesels and therefore offered less range. The substitution of turbines for diesels was also accompanied by an increase in the size of the fuel tanks, which necessitated a slightly longer hull and deeper draft. On the positive side, turbines raised the ships' top speed by 1kn. The latest Type D escorts built, and some repaired late in the war, were fitted with coal-burning boilers. The IJN's severe oil shortage at this point in the war made the conversion necessary.

Of the 143 Type D units planned, only 63 were completed. The design was simplified to the point where construction could be finished in 70 days even using small and medium-sized yards. However, late-war lack of materials extended average construction time to over three months. Armament of Type D escorts was identical to Type C escorts.

Table 25: No. 2 Class (Type D) specifications

Displacement	740 tons standard displacement; 900 tons trial displacement
Dimensions	Length 228ft 1in. overall; beam 28ft 3in.; draft 10ft
Speed	17.5kn
Range	4,500NM at 14kn
Crew	141 (design); rising to 185

No. 2 class *kaibokan* were identical to the No. 1 class except in their propulsion system. No. 2-class units carried turbines, which provided a slightly higher speed but much less range. This is *CD-2* in sea trials in February 1944. Note the different shape and placement of the stack for the turbine engines. (Yamato Museum)

THE COMBATANTS

THE USN SUBMARINE FORCE

At the start of the war, the majority of USN submarines in the Pacific were assigned to the Asiatic Fleet. Twenty-nine submarines were stationed in the Far East—six old S class, seven P class, six Salmon, six Sargo, and four Seadragon class. This left only 21 boats in the Pacific Fleet, and only nine of these were deployed to Pearl Harbor. Among these were six of the old V boats, the three latest P boats, and the 12 Tambor-class boats.

After the fall of the Philippines and the NEI, the Asiatic Fleet's remaining boats were based in Fremantle in Western Australia. These became the submarine force of the Seventh Fleet and were initially under command of Rear Admiral Charles Lockwood. In February 1943, Lockwood was moved to command the growing submarine base at Pearl Harbor. In 1942, Midway Atoll was used as a staging base for submarines departing Pearl Harbor. By April–May 1944, Manus in the Admiralty Islands and Majuro in the Marshalls were available as forward bases. Guam became the principal forward base in November 1944. Use of forward bases reduced the necessary transit time to reach patrol areas. When Guam was opened, patrol time in operational areas increased from 23 to 27 days.

SUBMARINE CREWS

Unlike the crews of the IJN's ASW escorts, which were considered to be second-rate even by their own commanders, USN submarine crews were an elite group with a high level of esprit de corps. The prewar US Navy was manned entirely by volunteers seeking a good career with adventure, steady pay, and security. Competition was intense to get a slot in the small peacetime navy. Even after the war began, so many

volunteers flooded US Navy recruitment offices that conscription was not necessary until late 1942. The quality of recruits accepted into the submarine force remained high for the entire war.

After basic training, sailors could volunteer for the submarine force. They were carefully screened, so only the best of the best went into subs. On average, one of ten applicants passed screening to become submariners. During the application process, they had to pass a series of physically and mentally challenging tests. The culmination of the tests was a series of simulated submarine escapes in an escape tower from depths up to 100ft. The final stages of training were conducted on old submarines. After graduation, not all new submariners went directly to submarines. Some were sent to man replacement crews (responsible for repairing subs returning from war patrols) or were sent to man new construction boats. The crew of an average boat consisted of about 60 enlisted men and six to eight chief petty officers. A good crew became very closely knit; if identified, a bad crew was broken up. Food was an important component of morale, and every effort was made to ensure its quality. Because of the length of patrols and the lack of facilities to refrigerate large quantities of food, by the end of a patrol the entire crew was reduced to eating powdered eggs and canned goods.

Boats were commanded by commanders or lieutenant-commanders who were referred to as "Captain" or "Skipper." At Lockwood's insistence, all fleet boats were commanded by Naval Academy graduates for the first three years of the war. At the start of the war, there was a real problem with submarine skippers trained under peacetime conditions not measuring up to wartime requirements. More aggressive officers were needed. This was done by giving younger officers—in their late 20s and early 30s at the rank of lieutenant-commander—command. Finding enough qualified officers to command was a continual problem. Lockwood balanced the need to put more aggressive skippers on the front line with his reluctance to possibly increase losses by placing inexperienced officers in command. In 1943, he relented, and began to give command to officers from the Naval Academy Class of 1935; though only about 30 years old, many of these officers became his star performers. By 1944, he was forced to give command to officers down to the Class of 1938 and even made two reservists commanding officers. Turnover of underperforming skippers was high during the war; 30 percent were relieved in 1942, 14 percent in 1943, and 14 percent in 1944. Turnover would have been even greater if Lockwood had more qualified men to turn to. A submarine wardroom was small. Aside from the captain, there was an executive officer, the engineering officer, the diving officer,

Lieutenant-Commander Dudley W. Morton, *Wahoo*'s commanding officer, shown at right with his Executive Officer, Lieutenant Richard H. O'Kane, on *Wahoo*'s bridge at Pearl Harbor after her highly successful third patrol, on February 7, 1943. Morton epitomized the new generation of aggressive USN submarine skippers and was third in the number of confirmed sinkings. O'Kane conducted five patrols with Morton and learned well. He was given command of Balao-class boat *Tang* and sank 24 ships on five patrols, making him second in the number of confirmed sinkings. (Naval History and Heritage Command)

VICE ADMIRAL CHARLES LOCKWOOD

Charles Lockwood, born in 1890, was a member of the US Naval Academy class of 1912. In 1914, he shifted to submarines, where he spent virtually the remainder of his career. When the US entered the war, Lockwood was a naval attaché in London. After gaining flag rank, he was appointed as Commander, Submarines, Southwest Pacific in Fremantle, Australia. This was a backwater command that Lockwood yearned to leave. His chance came when Rear Admiral Robert English, then Commander, Submarines, Pacific at Pearl Harbor, was killed in an air crash in January 1943. In spite of the backbiting from other senior submarine commanders, Lockwood was appointed to replace him the next month. This turned out to be an inspired choice.

Lockwood was a key factor in turning around the submarine force and making it the USN's most deadly component. He was devoted to the well-being of his men, who called him "Uncle Charlie." Among the measures that increased the operational effectiveness of his force was replacing ineffective skippers with younger, more aggressive officers. He ordered the deactivation of the suspect magnetic exploder on the Mark 14 torpedo in June 1943, and followed this by overseeing additional tests to correct problems with the contact exploder. One of the major problems restricting the effectiveness of USN submarines in 1942 was bad employment strategy. Lockwood learned these lessons and implemented several important measures in 1943 that came to full fruition in 1944. These included emphasizing patrols to Japanese home waters and the East China Sea with a focus on the critical Luzon Strait chokepoint. With Japanese convoys getting bigger and better defended in 1943, he authorized the use of wolf-pack tactics to bring increased firepower to break up Japanese convoys.

After leading the USN's submarine force to victory, he retired in 1947. Before dying in 1967, he wrote several books on naval history including one on the submarine war in the Pacific.

Vice Admiral Charles A. Lockwood, Commander Submarine Force, Pacific Fleet (center) on board *Balao* welcoming the submarine back to port from a successful war patrol in early 1945, probably at Guam. Lockwood made it a habit to meet every returning boat. (Naval History and Heritage Command)

communications officer, and the gunnery and torpedo officer, plus several watch standers. A typical wardroom was 12 officers when fully manned. Reservists made up about 50 percent of all wardrooms.

SUBMARINE ATTACK TACTICS

Prewar tactics were very conservative. Submarine commanders were trained to conduct submerged approaches and to fire torpedoes off sonar contacts. This was the result of prewar exercises during which submarines were assessed to be as good as sunk if they were detected. The effects of depth charges were greatly exaggerated, leading to the assessment that submarines were vulnerable. The ultimate effect was that officers were discouraged from being aggressive, and timid tactics were the norm. The submerged approach was slow and methodical and most often led to no attack because the target escaped or an ineffective attack.

As the war progressed, the crop of more aggressive skippers changed tactics. These were built on using radar to detect the target, and then using the submarines' surface speed to get ahead of the target to make a submerged attack. The surface search SJ radar, on board all submarines by late 1942, gave the submarines a huge tactical advantage over Japanese ships, which usually carried no radar until 1944. The range of the SJ was typically 8–10NM, but occasionally could extend out to 20NM.

The best profile for making a torpedo attack was placing the target on a right angle to the beam of the submarine. Using his periscope, the skipper would estimate the angle on the bow of the oncoming target and the direct range to the target. This information was fed into the Torpedo Data Computer (TDC), which generated a firing solution. Once introduced, the SJ radar on the periscope mast was useful in confirming the range of the target and its speed. Once the initial manual inputs were entered into the TDC, it would track the target and make any necessary adjustments to the torpedoes' gyros. The optimum range to launch the torpedo was 1,000yd. The number of torpedoes fired at a target depended on its importance and the boat's remaining number of torpedoes. High-value targets might get a full six-torpedo salvo. A typical late-war spread against a merchant ship was three torpedoes. If the target information was correct, such a spread was expected to score two hits.

Sculpin at the Bethlehem Steel Company Shipyard in San Francisco on May 1, 1943 following an overhaul. This view of the forward end of her sail identifies changes recently made to the ship. The boat carries two types of radar. The first to be fitted on submarines was the SD air-search radar (seen on the tallest mast). This was followed by the much more reliable SJ surface search radar. (Naval History and Heritage Command)

IJN ASW ESCORT CREWS

Additional proof that ASW was an afterthought for the IJN was provided by the quality of men assigned to escorts. There were many reasons for this. The IJN was built for and trained to conduct offensive warfare. ASW was a defensive operation built around the monotony of escorting merchant ships. ASW was therefore viewed as a tertiary responsibility for the IJN and one to be avoided by any self-respecting Japanese naval officer. This was true for those assigned to sea commands, as well as to staff duty. To illustrate this point, before the war the operations division of the Naval General Staff had a single officer assigned to defense of shipping. In the headquarters of one of the larger naval stations (responsible for coastal defense), there was a single officer responsible for shipping defense.

The IJN was also guilty of mirror imaging with regards to the wartime mission of the USN's submarine force. The IJN's submarine force was firmly wedded to the requirement of supporting operations of the main fleet. The mission of Japanese submarines was to attack the enemy's fleet. Attacking merchant shipping was a mission, but one of clear secondary importance. The IJN assumed that the same held true for the USN's submarine force.

ATTACK ON A JAPANESE CARGO SHIP

This shows the view through a USN attack periscope at the moment that a Japanese cargo ship has been struck by a torpedo. Use of the periscope in this manner would only be made in the absence of a reaction by IJN escorts.

When the war commenced, there was no single unit responsible for defense of shipping. Merchant ships were not required to steam in convoy since this reduced the efficiency of available shipping. In the case of troop convoys, including the many invasion convoys deployed during the period of Japanese expansion in the first few months of the war, the Combined Fleet took responsibility for defending them against submarine attack.

The first dedicated escort force was established on April 10, 1942. Even this move showed the IJN's continuing neglect of trade protection. The First Escort Group was allocated ten old destroyers, two torpedo boats, and five converted gunboats to protect ships headed back and forth from Japan to Singapore. The Second Escort Group was given four old destroyers, two torpedo boats, and one converted gunboat to protect the sea lanes from Japan to Truk in the Central Pacific. The effectiveness of these commands was compromised by a lack of staff officers to administer their operations.

The next step was the establishment of an independent division in the Naval General Staff to oversee shipping defense. This was effective on October 10, 1942, almost one year after the start of the war. The section was given a total of four staff officers. Just over one year later, on November 15, 1943, the ASW effort received a major boost with the establishment of the Grand Escort Command Headquarters (GEHQ). This entity was given control over the First and Second Escort groups and the local forces of all major and minor naval stations, and had the authority to control all convoy routings. Only a few local routes were beyond the control of the GEHQ.

Though the establishment of a dedicated ASW command was a major step forward, it did not come with a commensurate increase in the number of forces allocated to trade defense. As of November 15, 1943, the GEHQ had fewer than 50 ocean-going escorts. These were a mix of converted gunboats, the oldest destroyers in the fleet, and the first *kaibokan* to enter service. Of these, only four destroyers were organized into

As the war progressed and the threat to their shipping increased, the Japanese converted any ship with adequate speed and endurance into ASW escorts. Among these was the ex-USS *Stewart*, a USN destroyer that capsized in dry dock in Surabaya in February 1942 and was placed back into service as *Patrol Boat No. 102* by September 1943. On August 24, 1944, the ship played a role in the destruction of *Harder*. (Yamato Museum)

and operated as a coherent division. The others operated independently, meaning they were temporarily organized into ad hoc groups as required. This precluded them from working together to develop tactics or even communications procedures. IJN training for ASW was also inadequate, with new escorts being thrown immediately into battle without an opportunity to work up and to master ASW tactics and develop new ones.

The *kaibokan* reaching the GEHQ were crewed by the IJN's second string. The great majority were commanded by graduates of the merchant marine academies. Such graduates were untrained in tactical matters and lacked the aggression of their Etajima Naval Academy contemporaries. The GEHQ pleaded for Naval Academy graduates to increase the level of training and to establish standing groups, but these personnel were in short supply and never received orders from the GEHQ. Only in about April 1944 was a command set up called the Escort of Convoy Headquarters. This was structurally deficient since it was activated immediately before each convoy departed and deactivated when the convoy arrived at its destination. After its brief period of independence, the GEHQ was subordinated to the Combined Fleet in August 1944. This included the 901st Naval Air Group with its radar-equipped aircraft. The Combined Fleet threw it into action in October in the air–sea battle off Taiwan, during which this specialized unit was decimated.

Technical personnel assigned to shipping defense were in short supply. An example was communications personnel, as demonstrated when attempts to install an intra-convoy radio telephone system was only partially successful, since adequate numbers of trained personnel were unavailable for the merchant ships. The same situation was experienced with radar operators. After the Combined Fleet received radar, the GEHQ began to see some of its ships equipped with radar in the spring of 1944. The poorly trained escort crews never proved proficient in its use. When available, it was used sparingly, primarily at night and in bad weather. This was the result of a reluctance to use radar to avoid being detected by the Americans.

JAPANESE ASW TACTICS

Given the short range of sonar, it was rarely the first mode of detecting enemy submarines. ASW engagements almost always began with visual contact on a submarine. After sighting a submarine and forcing it to submerge, IJN ASW escorts tried to convert the visual contact into a sonar track. The escort would move quickly to where the submarine was sighted and drop depth charges. Even if sonar contact was

ADMIRAL KOSHIRO OIKAWA

Oikawa was one of the IJN's most influential admirals before the war. Among his posts during the war was as the first commanding officer of the Grand Escort Command Headquarters (GEHQ). Despite the GEHQ receiving a senior admiral as its first leader, it remained starved of resources.

Born in 1883, Oikawa graduated from Etajima Naval Academy in 1903. After a steady climb, he gained flag rank in 1928. After a number of important posts, including command of the Third Fleet (responsible for operations off the Chinese coast), he was promoted to full admiral in November 1939.

Before the war, he was Navy Minister until being dropped from Prime Minister Tojo's cabinet in October 1941. He was reluctant to go to war with the United States, but supported the Tripartite Pact and Japanese expansion into Indochina. After serving as Director of the Naval College, he was appointed as the GEHQ's first commander in November 1943. In his new job, he personally came up with a plan to protect Japanese shipping.

His scheme tried to balance the requirement of keeping the limited number of ships flowing efficiently around Japan's far-flung empire with the fact that there weren't enough forces available to protect them. To address this dilemma, Oikawa planned to create a sanctuary in the East China and South China seas, linked by the Taiwan Strait, in which shipping could steam independently without forming convoys to maintain the highest level of efficiency. The sanctuary would be created by defending the island barrier formed by the Ryukyus, Taiwan, the Philippines, and Borneo with mine barriers. Where there were gaps between islands, these would be defended by land-based sensors and patrol ships and aircraft. In the area of the Bonin Islands south to the Marianas, ships would steam in convoys protected by radar stations on nearby islands and patrol ships and aircraft. The same level of protection would be extended to ships steaming in the Home Islands.

Though promising, Oikawa's scheme failed from lack of resources. Mines were in short supply, as were minelayers. By the time minelaying was ready to begin, the Japanese lost air control of the areas to be mined. On August 3, 1944, Oikawa was promoted to chief of the Naval General Staff and subsequently resigned in May 1945 in protest over the Emperor's refusal to entertain American peace proposals. The fact that he was unable to change the fortunes of the GEHQ demonstrates that the task was impossible.

Admiral Oikawa commanded the Grand Escort Command Headquarters from November 1943 until August 1944. During this period, USN submarines established dominance in Japan's critical sea lines of communications. (CC-BY-SA-4.0)

gained, it was lost when the escort approached the target since sonars of the period could not track targets close to the ship. The longer this blind period was, the less accurate the depth-charge attack.

When a depth-charge attack was conducted, it was usually not of sufficient duration. Most American submarine skippers noted that IJN escort attacks were quickly broken off. Japanese depth charges were inferior and carried a relatively light payload. They were rarely set to explode below 150ft. The Japanese seemed unaware

of the diving capabilities of USN subs. Part of this misconception was due to mirror imaging. Given that the diving depth of most prewar IJN submarines was about 200ft, the Japanese assumed the same held true for USN subs as well. If the target submarine was caught in shallow water, the failure to set the depth charges to explode deep did not matter. Otherwise, a submarine skipper could dive to 200ft and escape the worst of a depth-charge attack. Even after making a cursory attack, IJN escorts often claimed a kill. This dramatic over-claiming hid their actual lack of success.

Among the most effective IJN ASW weapons was the moored sea mine. Minefields were laid to protect the most heavily trafficked shipping routes. The approaches to the East China Sea were heavily mined since waters in the area were shallow, making mines more useful. Other chokepoints, like the Taiwan Strait, the straits into the Sea of Japan, and chokepoints in the NEI and the Philippines were also mined. Even though the effectiveness of the IJN's minefields was undermined by American capture of Japanese charts that indicated their locations, the Japanese continually expanded their mining operations, making it hard for the Americans to determine what areas were mined. Late in the war, the FM sonar reached the submarine fleet that could detect mines.

One area of excellence for the Japanese was their use of high-frequency direction finding. They intercepted most radio signals from USN subs and were able to fix them to a relatively small area. Though this was nowhere near sufficient for targeting purposes, it did provide them with the primary means to track USN submarines while deployed. It gave them insight into how many submarines were active during a given time and where they were operating.

An integral part of successful ASW operations is the application of air power. Air cover for the GEHQ was provided by the 901st Naval Air Group. However, the allocation of a dedicated air group to defend shipping was less than it appeared. There were no aircraft specifically built for this purpose and no doctrine for their use. No aircrews were trained for this mission. Doctrine and tactics had to be developed on the fly, and so pressing was the situation that the air group was forced to begin operations in mid-January 1944 despite inadequate time for training and tactics development. Japanese ASW aircraft had no way to communicate directly with ASW escorts. Radar carried aboard these aircraft was theoretically capable of detecting a surfaced submarine at 12NM. However, radar doctrine called for it to be used only at night or in low-visibility conditions, otherwise visual searches were preferred. Japanese ASW aircraft also carried a magnetic anomaly detector that could pick up a large metal object (like a submarine) within 150yd of the aircraft. Aircraft flying at low altitudes could therefore detect subs at shallow depths. Though the system often picked up sunken wrecks, the Japanese thought this system to be effective and claimed several sub kills from detections gained from it.

An area of almost total failure for the IJN was its use of carriers to escort convoys. The Japanese completed five escort carriers; of these, four were sunk by submarine attack. Most were used as aircraft ferries and rarely as ASW carriers. The first one did not join a convoy as an ASW platform until July 1944. One was never assigned to convoy duty. Only one of the five ever escorted a convoy more than once. As was the problem for fleet carriers, there was a shortage of aircrew. As soon as the escort carrier aircrew completed a convoy run, they were taken off and sent to a fleet carrier. No USN submarine was sunk by an IJN escort carrier, and only one was even attacked by aircraft operating from an escort carrier.

COMBAT

THE BATTLE AGAINST JAPANESE SHIPPING IN 1941–42

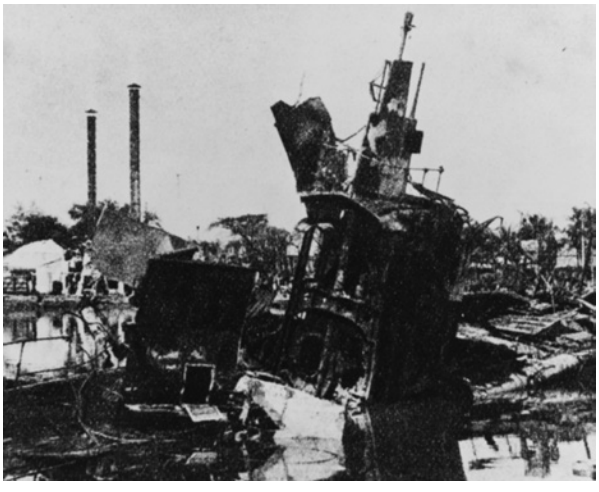
THE ASIATIC FLEET

At the start of the war, USN submarines assigned to the Asiatic Fleet had the near-impossible mission of defending the Philippines from Japanese invasion. The war began poorly for the submarine force when Cavite Navy Yard was attacked by Japanese bombers on December 10, 1941. *Sealion*, undergoing overhaul, was destroyed and *Seadragon* was damaged. More importantly, the submarine support facilities at the base were destroyed along with 233 Mark 14 torpedoes.

Twenty-two of the fleet's 29 submarines were deployed to defeat an invasion. In late December 1941, the focus of submarine operations belatedly shifted to Lingayen Gulf on Luzon, which was the most likely spot for a large-scale Japanese landing. After a huge invasion convoy with 73 transports appeared in the gulf, seven submarines were sent to attack it. Only *S-38* got through the screen to sink a single freighter. The results were more than disappointing; they were a condemnation of the combat effectiveness of the USN's submarine force. In all of December 1941, USN submarines made 45 attacks and fired 96 torpedoes. Eleven ships were claimed sunk, including two destroyers. In fact, only three were sunk, including the one inside Lingayen Gulf. There were many reasons for this dismal failure, including excessive dispersal of effort, conservative tactics, poor material conditions of the submarines, and problems with the Mark 14 torpedo. After the total failure of the submarine force to deter an invasion, it was withdrawn to Surabaya in the NEI on December 31, 1941.

OPPOSITE
Principal Japanese shipping lanes and USN submarine losses, 1941–43.

US submarine loss
Japanese convoy routes
Kamchatka
USSR
Sakhalin
S-44, Oct 7, 1943
Paramushiro
Karafuto
MONGOLIA
MANCHURIA
Wahoo, Oct 11, 1943
Oturu
Muroran
Runner, c. Jun 26 1943
Pickerel, c. Apr 3, 1943
Pompano, c. Sept 17, 1943
Rashin
JAPAN
Dairen
Gensan
Niigata
KOREA
Tsingtao
Maizuru
Tokyo
Osaka
Moji
Grunion, Jul 30, 1942 (near Kiska)
S-27, Jun 19, 1942 (near Amchitka)
Kagoshima
CHINA
Shanghai
BONIN ISLANDS
Keelung
Formosa
Takao
Hong Kong
PACIFIC OCEAN
BURMA
Hainan
MARIANAS ISLANDS
Saipan
Rangoon
Grayling, c. Sept 9, 1943
THAILAND
Manila
Sealion, Dec 10, 1941
INDOCHINA
PHILIPPINES
Ormoc
Saigon
MARSHALL ISLANDS
Grenadier, Apr 21, 1943
Cisco, Sept 28, 1943
Davao
Truk
Sculpin, Nov 19, 1943
PALAU ISLANDS
Corvina, Nov 16, 1943
MALAYA
Shark I, c. Feb 8, 1942
Medan
Morotai
Singapore
BORNEO
Capelin, Dec 9, 1943
Halmahera
Balikpapan
Biak
Triton, Mar 15, 1943
SUMATRA
Celebes
Hollandia
Amberjack, Feb 16, 1943
Ceram
Palembang
Rabaul
NEW GUINEA
Perch, Mar 3, 1942
Makassar
Amboina
SOLOMON ISLANDS
Belitung
Argonaut, Jan 10, 1943
S-36, Jan 20, 1942
Surabaya
Grampus, Mar 5, 1943
Java
Timor
S-39, Aug 14, 1942
INDIAN OCEAN
N
0
800 miles
0
800km
AUSTRALIA

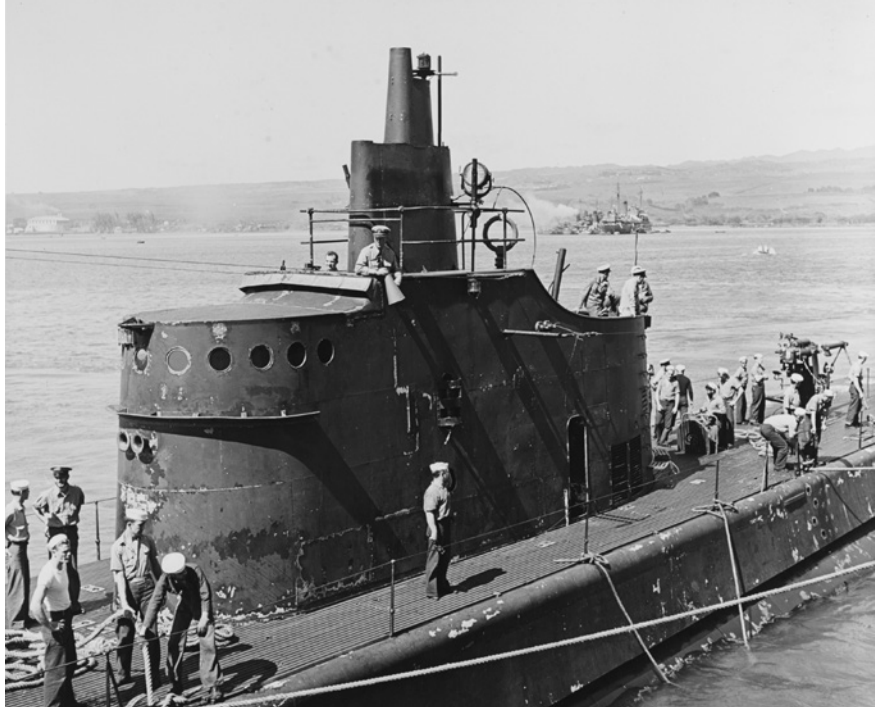


The wreckage of *Sealion* at the Cavite Navy Yard after its capture by the Japanese. *Sealion* was fatally damaged by Japanese bombs on December 10, 1941 and was scuttled on December 25 before Cavite was abandoned. (Naval History and Heritage Command)

After being withdrawn to Surabaya, the 28 remaining submarines were tasked to defend the NEI. For the same reasons already mentioned, the pattern of failure repeated itself. When 11 submarines were sent to intercept a Japanese invasion force leaving Davao on Mindanao, the Japanese force had already departed. In all of January 1942, only three Japanese freighters were sunk. In return, *Shark* was lost on February 11, 1942 to a probable IJN destroyer attack in the Makassar Strait and *S-36* ran aground on January 20.

In February 1942, 17 of the remaining 26 submarines were positioned east of Java to intercept an expected Japanese invasion. Though the Java Sea was thick with Japanese ships, none were sunk by submarine attack. The total haul for the month by Asiatic Fleet submarines was two freighters. In March 1942, the campaign for the NEI came to an end. For the entire month, only two Japanese ships were sunk—a 6,500-ton tanker on March 4 by *S-39*, and a valuable 6,440-ton aircraft ferry in the Lombok Strait two days later. *Perch* was lost on March 1, 1942 after a three-day ordeal north of Surabaya, being damaged by destroyer depth-charge attack and then finished off by gunfire.

After the fall of the NEI, 19 boats headed for Fremantle on the west coast of Australia. It was decided to keep them there, and for the rest of the war Fremantle was a major USN submarine base. This was an unproductive choice since it placed these



Trout arriving at Pearl Harbor in early March 1942 to unload a cargo of gold that she had taken on board at Corregidor on February 4, 1942. Note the early-war sail with no radar and only a .30-caliber machine gun mounted aft of the periscope housing. *Trout* was sunk on her eleventh patrol after accounting for 12 Japanese ships. (Naval History and Heritage Command)

submarines at the end of a tenuous supply line. Submarines operating from Fremantle never accomplished what submarines operating from Pearl Harbor did. For example, from May to August 1942, the 20 boats based there accomplished little. On 28 patrols, only 17 Japanese ships were confirmed sunk.

During the final quarter of the year, Fremantle submarines managed 17 patrols, but their performance continued to be disappointing. They accounted for 16 confirmed sinkings—less than one per patrol. Among the reasons was a low number of operational boats, not enough torpedoes, dispersed operations all over Southeast Asia, and a continued lack of aggression by the skippers concerned.

SUBMARINE PATROLS FROM PEARL HARBOR

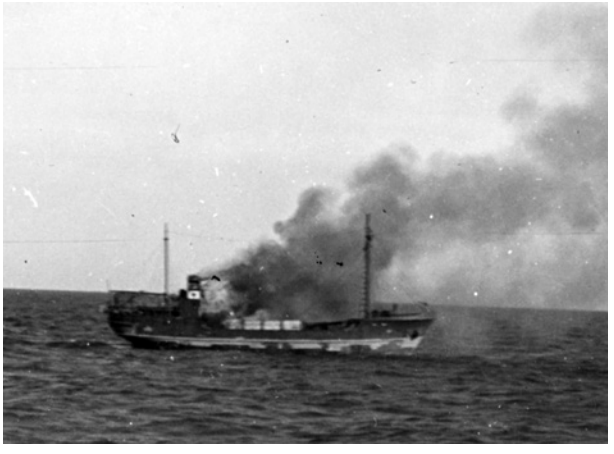
Triton was the first USN submarine to fire live torpedoes at a Japanese ship, when she engaged a target on December 10, 1941 off Wake Island. Her skipper claimed a hit and a kill, but in fact the attack hit nothing. On December 11, *Gudgeon* departed Pearl Harbor with the distinction of making the first patrol into Japanese home waters. The boat made several attacks on merchants, but despite claims of success, hit nothing. On her way back to Pearl, *Gudgeon* sank IJN fleet submarine *I-173* with a three-torpedo spread on January 27, 1942. *Gudgeon* was followed to Japanese home waters by two other boats, and they sank four ships for a total of about 15,000 tons.

The first wave of submarines leaving Pearl Harbor also included four boats ordered to attack targets in the Marshalls. Again, despite claims of success, none actually sank a target. In total, the first seven boats sent on patrol from Pearl Harbor sank a total of four ships, plus *I-173*.

Patrols out of Pearl in January 1942 were still divided among the Marshalls, Truk Atoll in the Central Pacific, and the Japanese home waters. On many occasions, boats were sent to make interceptions of targets being reported by Ultra intelligence (information from decoded Japanese messages named after its classification). Invariably, such operations came up dry. In February 1942, seven patrols were conducted with every boat sinking at least one Japanese ship. Only four patrols were mounted in March. Of the 17 total patrols during the first quarter of 1942, 22 claims for Japanese ships were submitted, but postwar analysis confirmed only 15. The usual problems remained in effect—dispersal of effort, bad torpedoes, and bad tactics. The Mark 14 had already gained such a poor reputation that some skippers surreptitiously deactivated the magnetic detonators.

Operations during the next quarter were disrupted by the requirement to defend Midway Atoll in June 1942. In April, 14 patrols were conducted, eight to the Japanese home islands. *Drum* conducted the best patrol of the war so far when she sank the large seaplane carrier *Mizuho* and three other ships for a total of 20,000 tons off Japan. In May, the difficulty in using Ultra intercepts to guide targeting was dramatically demonstrated. The damaged fleet carrier *Shokaku* was chased by as many as eight submarines on her way back from the Coral Sea to Japan. No submarine was able to spot the carrier, much less conduct an attack.

An all-out effort by the submarine force was mounted to defend Midway. Nineteen boats were positioned near the atoll, with another seven off Hawaii. The return for this investment was slight. After playing cat and mouse with the Japanese carrier force throughout the morning of June 4, *Nautilus* got herself into a good firing position



A Japanese trawler burns on July 8, 1942 after being attacked by *Pompano*. This occurred on the boat's third patrol, during which she sank three ships off Japan. This trawler did not count since it was less than 500 tons. Such small ships were usually not judged to be worth a torpedo, and so were dispatched by gunfire. (Naval History and Heritage Command)

Shunko Maru (6,781 tons) sinking in the central Pacific after being torpedoed by *Skipjack* on October 14, 1942. On ten patrols, *Skipjack* sank six ships, including one destroyer. (Naval History and Heritage Command)

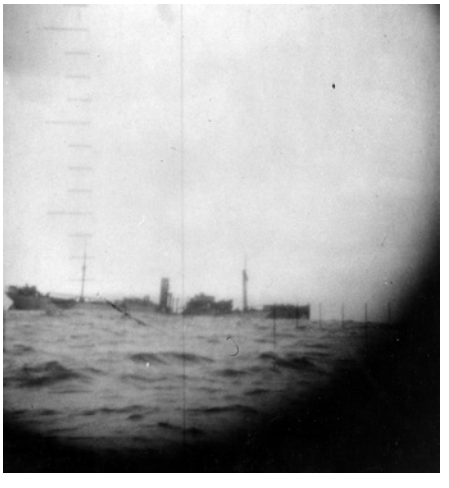
against the damaged carrier *Kaga*. One of the three torpedoes hit the carrier, but it failed to explode and the body of the torpedo was used as a life raft by Japanese sailors in the water. *Tambor* was patrolling off Midway when she was sighted by a force of IJN heavy cruisers. In the ensuing chaos, two cruisers collided and were damaged. Unable to depart the area, one was later sunk by American carrier aircraft and the other heavily damaged.

The second quarter of 1942 was marginally productive for Pearl Harbor boats. Of the 21 offensive patrols from Pearl Harbor, 22 Japanese ships were confirmed as sunk. On the other hand, not a single Pearl Harbor boat had been sunk during the war to date. Robert English, Commander, Submarines, Pacific since May, was proud of this record. English was also busy during this time weeding out those skippers who failed to perform; 12 were relieved.

Beginning in July 1942, English focused on blockading Truk. Eleven boats were dispatched to this heavily defended area in the third quarter of the year, followed by 18 in the final quarter. Midway was used as a staging base to allow the boats to refuel and reprovision before leaving on patrol. The results were disappointing. One bright spot was the torpedoing of escort carrier *Taiyo* on August 28—the first hit on an IJN carrier during the war. Also, during this period, SJ radar began to be fitted on fleet boats.

The focus on Truk left only 20 boats to patrol the waters off Japan or the Aleutians between July and October 1942. *Guardfish* made a fine patrol off Honshu claiming six ships in 11 days, including four in one day. Five of the victims were later confirmed as sunk.

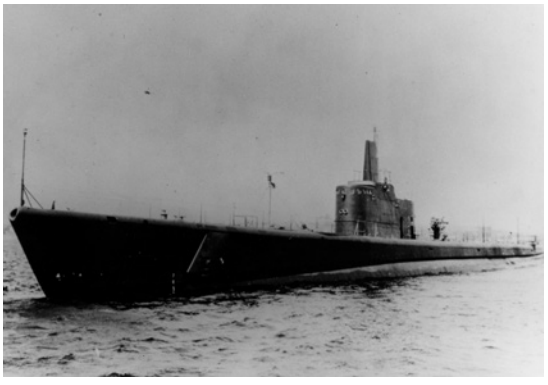
During the final two months of the year, English only mounted ten patrols from Pearl Harbor. Available submarine numbers dropped with the retirement of five old boats to training duties, and two squadrons were transferred to Brisbane to support South Pacific operations. During the second half of the year, 61 patrols were conducted, including 29 against Truk and 27 to the waters off the Japanese home islands or the East China Sea. Of these, only 34 patrols resulted in a confirmed sinking.



SIDESHOW IN THE ALEUTIANS

Another dispersal of effort for the USN submarine force was in the Aleutians, where the Japanese had seized two islands in June. Ten S-class boats were dispatched to Dutch Harbor, later supported by patrols by seven fleet boats from Pearl Harbor. Targets were few; the S boats sank one small freighter in all of 1942. In return, *S-27* ran aground on July 19 and was lost. The fleet boats took up a private war with IJN destroyers in the area. *Growler* sank one and damaged two, and *Triton* sank another in July. *Grunion* was also active against Japanese destroyers, evading an attack on July 15 and missing her

tormentors with three torpedoes. Later that day, she sank two submarine chasers. Sometime after July 30, *Grunion* was lost, but some questions remain as to the cause.



Grunion, photographed in 1942 in her original configuration, was a Gato-class boat lost on her first patrol. She was active off Kiska Island in the Aleutians during July 1942, and accounted for two IJN submarine chasers during that time. On July 30, she reported intensive ASW activity, but IJN records failed to corroborate this. In 2008, the discovery of her wreckage was confirmed, and evidence emerged that her loss was due to faulty torpedoes. She fired four at a Japanese merchant; one ran too deep, two hit the ship and failed to explode, and the last circled back to hit the submarine's periscope support, which probably led to a loss of depth control. (Naval History and Heritage Command)

SUBMARINE PATROLS FROM BRISBANE

When the focus of the Pacific naval war shifted to the South Pacific, the USN established a submarine force in Brisbane on the east coast of Australia. Originally, this was limited to six S-class boats under Captain Ralph Christie. During the Battle of the Coral Sea in May 1942, four S boats were active, sinking a 4,400-ton minelayer. As the American and Japanese navies struggled for control of Guadalcanal in the Solomons beginning in August, the 11 S boats in Brisbane contributed little. Between May and September, only two boats scored. *S-44* sank the heavy cruiser *Kako* in August, followed by a gunboat. *S-38* sank a 5,600-ton transport off Bougainville. Conditions aboard the old S boats operating in the South Pacific were brutal, with temperatures going up to 105–120 degrees when submerged.

By the end of 1942, Brisbane was the host of the largest concentration of USN submarines in the Pacific. Patrols were focused on the Solomons into waters heavily patrolled by IJN ASW units. Of the 24 patrols during the final quarter of the year, 19 by fleet boats, only three boats recorded any success. These sank six Japanese units, including two IJN submarines. The star performer was *Silversides*. She survived a depth-charge attack by a destroyer before arriving in her patrol area west of Truk. *Silversides* sank a 10,000-ton tanker before turning her attentions in January 1943 on

Captain Ralph W. Christie, commander of the USN submarines based in Brisbane, congratulates the commanding officer of *S-44*, Lieutenant-Commander John R. Moore. The photograph was probably taken after *S-44* returned to Brisbane on August 23, 1942 following the patrol in which she sank heavy cruiser *Kako*. (Naval History and Heritage Command)

a convoy of four freighters and two escorts. Her skipper skilfully fired a full torpedo salvo at three overlapping freighters. The five torpedoes hit three ships, sinking all of them. With a total of 27,798 tons, it was the most successful patrol of the war so far by tonnage.

THE BATTLE AGAINST JAPANESE SHIPPING IN 1943

The year began with a shuffle of American submarine commanders necessitated by the death of Rear Admiral English on January 20. After much jockeying, Rear Admiral Charles Lockwood was selected as his replacement. Newly promoted Rear Admiral Christie replaced Lockwood in Fremantle and Captain James Fife replaced Christie in Brisbane.

SUBMARINE PATROLS FROM PEARL HARBOR

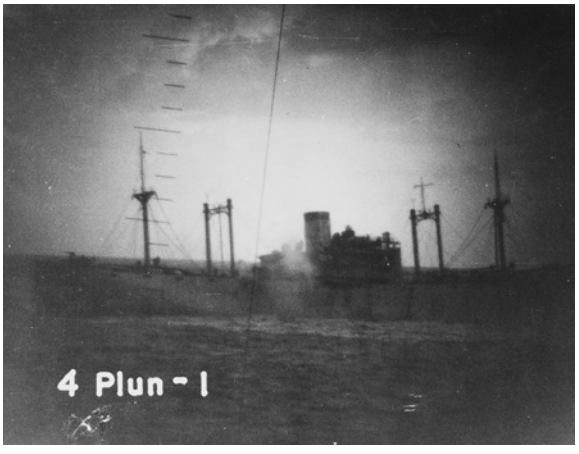
During the first three months of the year, 28 patrols departed Pearl Harbor—12 to Japanese home waters and 16 to the Central Pacific. The result was somewhat disappointing, with 27 of the patrols accounting for 25 confirmed kills. The exception was the second patrol by Commander "Mush" Morton on *Wahoo*. Sent to the Yellow Sea in March 1943, he single-handedly accounted for nine confirmed sinkings of some 20,000 tons. This was the largest number of ships sunk on a patrol yet, making Morton an instant legend. The first Pearl Harbor-based boat was lost in March, when on her seventh patrol *Pickerel* failed to return, probably having been sunk by IJN small ASW vessels.

In the second quarter of the year, the number of available boats in Pearl Harbor rose to 54. The retirement of older boats was more than made up for by a flood of new construction. This allowed 91 patrols to be conducted from April to August. For the first time, patrols to Japanese home waters outnumbered those to other areas. These continued to be more successful than patrols to other areas. The 53 patrols to Japanese waters accounted for 64 kills; those 38 patrols to various Central Pacific islands resulted in only 21 sinkings. It was during this period that the issue with the Mark 14's magnetic exploder came to a head. Two events made Lockwood finally give up his defense of the magnetic exploder. One was Morton's third patrol to the Kuriles, when the faulty exploder cost him at least three sinkings, and the other an Ultra-directed attack on IJN carrier *Hiyo* on June 10 by *Trigger*, during which only two of the six torpedoes hit and exploded. On June 24, the order finally went out to deactivate the magnetic exploder. In Fremantle, Christie did not follow suit, creating confusion on the boats shuttling between the two commands.

Nittsu Maru (2,183 tons) sinking in the Yellow Sea on March 23, 1943. This periscope photograph was taken from *Wahoo* on her fourth patrol, during which she sank nine confirmed Japanese ships, making it the second-best patrol of the war for USN submarines. (Naval History and Heritage Command)

Between July and September 1943, Lockwood opened a new front by sending eight subs into the Sea of Japan. The first group of three submarines, entering through the La Pérouse Strait, achieved poor results, with only three small freighters sunk. The second group, which included Morton's *Wahoo*, sank only another two (neither by Morton). Two boats, *Runner* and *Pampano*, operating northeast of Honshu, were lost, both probably to mines.

During the final months of 1943, Lockwood dispatched 89 patrols. Of these, 39 reported no successful attacks, indicating that problems with less than aggressive skippers persisted. The other 50 patrols gained 99 confirmed sinkings.



Kinai Maru (8,360 tons) was sunk by *Plunger* on May 10, 1943 on her sixth patrol. *Plunger* went on to sink 12 ships in 12 patrols. (Naval History and Heritage Command)

Among the notable actions was the sinking of escort carrier *Chuyo* by *Sailfish* on December 12, 1943 off Japan. This was the first IJN carrier lost to submarine attack during the war. On December 25, *Skate* damaged superbattleship *Yamato* with a single torpedo in an Ultra-directed attack.

Lockwood endorsed wolf-pack tactics in the final months of the year. The first, comprised of three boats, ravaged a convoy on October 12 and claimed five ships sunk and eight more damaged during their entire patrol. Lockwood considered it a success, but this first attempt was not a joint attack by the three boats involved, rather it was a joint search mission. Communications issues had to be addressed before true wolf packs could be employed. The second wolf pack in November featured three boats sent to the Marianas. It experienced more communications problems, but still accounted for seven confirmed sinkings. The third, in December, succeeded in damaging escort carrier *Unyo*.

USN submarine losses were notable, if only because of the profound shock from the loss of *Wahoo* on October 11, 1943 as she was departing the Sea of Japan. At the time of his death, Morton was one of the top skippers in terms of ships sunk. *Sculpin* was sunk by a destroyer east of Truk on November 18, and just days later *Corvina* became the only USN boat to be sunk by a Japanese submarine during the entire war.

The combat saga of the S boats concluded in 1943. Operating from Dutch Harbor in the Aleutians, 33 patrols were conducted in 1943, with only four ships confirmed sunk. In return, *S-44* was sunk on her fifth patrol by *kaibokan Ishigaki* on October 7. After sinking a total of 14 ships during a total of 190 patrols, the S boats were retired to training duties.

SUBMARINE PATROLS FROM BRISBANE

The end of the Guadalcanal campaign in early 1943 meant a decrease in the number of targets in the Solomons. Accordingly, two squadrons were transferred from Brisbane back to Pearl Harbor. By May 1943, the force in Brisbane was down to eight boats.

The year started badly for Fife's boats. The cruiser submarine *Argonaut* was sunk by IJN destroyers on January 10 with the loss of all 105 aboard. Five boats departed for patrols in February; of these, three were lost. After sinking a freighter on February 4, *Amberjack* was spotted by a Japanese patrol aircraft that called torpedo boat *Hiyodori*

PREVIOUS PAGES

The death of USS *Sculpin*. While stalking a convoy east of Truk on November 19, 1943 on her ninth patrol, *Sculpin*'s periscope was spotted by IJN escorts, including destroyer *Yamagumo*. The escorts attacked with depth charges, but *Sculpin* survived. However, while later coming up to periscope depth, the submarine accidentally broached and disclosed her position to the waiting *Yamagumo*. The ensuing depth-charge attack inflicted severe damage, leaving her skipper with only the choice to come to the surface and fight it out. In an unequal gunfight, the destroyer's first salvo hit *Sculpin*'s bridge, killing the skipper and executive officer. The order was given to abandon the boat and scuttle her. Forty-one of her crew were picked up by the Japanese. Among those who did not survive was Captain John Cromwell, aboard as a wolf-pack commander. He elected to go down with the boat since he had knowledge of the impending invasion of the Gilberts and of Ultra intelligence. He was awarded the Medal of Honor for his sacrifice.

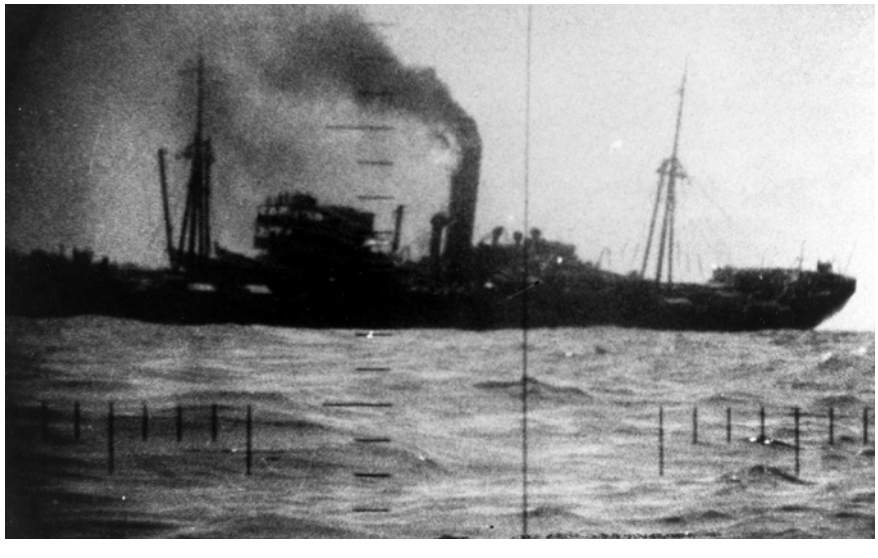
and a sub chaser to the scene. Their depth-charge attack sank *Amberjack*. This loss was followed by that of *Grampus* on March 5 or 6 in the Blackett Strait. The likely agents of her destruction were IJN destroyers. The run of bad luck for the Americans continued when on March 15, *Triton* was sunk by depth-charge attack north of the Admiralty Islands.

In January 1943, Morton on *Wahoo* gained instant fame. In a patrol off New Guinea, Morton's aggressive tactics set the pattern for other skippers to emulate. At Wewak, he hit and damaged a destroyer with a "down the throat" shot from only 800yd. Morton then spotted and ravaged a convoy of four ships. He claimed one tanker, one transport, and two freighters, but the tanker actually survived. After sinking the transport, Morton surfaced and ordered his crew to attack the hundreds of survivors in the water. Few American submarine skippers were that ruthless.

During the first five months of the year, Fife's command mounted 25 patrols and accounted for 18.5 ships. In return, four boats were lost. During the remainder of the year, the 12 boats averaged five patrols per month. In the 33 patrols, 29 confirmed sinkings were gained. No boats were lost. Patrols focused on convoys to and from Rabaul. Since these were heavily escorted, results were comparatively meager. The exception was when Fife used Ultra to mass four boats on an important convoy from Palau to Rabaul in November. Despite the efforts of the escorts, four of the five ships in the convoy were destroyed. This success was followed the next month by another massed attack on a convoy of three tankers and two destroyers. The three boats sank two of the tankers and one of the destroyers. These were not true wolf-pack attacks since there was no single commander in charge and no attempt was made to coordinate attacks, but it was a step in that direction.

PATROLS FROM FREMANTLE

For the first six months of 1943, boats from Fremantle posted disappointing results. On 22 patrols, nine of which resulted in no loss to the enemy, 23 Japanese ships were sunk, according to postwar analysis. The star performer was *Gudgeon*. Carrying only



Buyo Maru (5,447 tons) sinking after she was torpedoed by *Wahoo* off northern New Guinea on January 26, 1943. *Wahoo* sank three ships this day on the first patrol under Commander "Mush" Morton. (Naval History and Heritage Command)

16 torpedoes, she claimed four ships (of which two were confirmed postwar), and on a subsequent patrol sank the 17,500-ton liner *Kamakura Maru*, the largest ship yet sunk by USN submarines.

In return, *Grenadier* was lost on her sixth patrol on March 21 in the Strait of Malacca by air attack, and *Grayling* was lost on her eighth patrol in August or September in the South China Sea due to unknown cause.

For the remainder of the year, Christie gave orders for his commanders to focus on sinking tankers. The tanker offensive produced results. Of the 43 ships sunk during the second part of the year, 12 were tankers. This did have the desired effect of producing fuel shortages for the Combined Fleet anchored at Truk and in Japan. Tankers were a critical node for the Japanese war economy and targeting them was a step long overdue. In November, *Billfish* conducted an epic patrol, recording the largest score on a single patrol to date. Hitting with 19 of 24 torpedoes, 14 ships were claimed for a total of 71,000 tons (postwar review reduced this to ten ships of 27,000 tons). Two boats were lost during this period: *Cisco* on her first patrol on September 28 to air and naval attack, and *Capelin* on her second patrol in December to unknown causes.

1944: THE SHIPPING WAR IS DECIDED

At the start of 1944, the USN had almost 100 boats available in the Pacific. This was enough to support offensive operations while intensifying the antishipping campaign. These boats carried reliable torpedoes, were commanded by an increasingly aggressive and capable group of younger officers, effectively employed wolf-pack tactics, and were focused on critical chokepoints that Japanese shipping had to transit. In comparison, the IJN's ASW force fell further behind in terms of capabilities. Though more ASW escorts were in service, they proved unable to contend with the submarine assault due to poor tactics, poor equipment, and poor leadership. The result was a massacre of Japanese shipping.

SUBMARINE PATROLS FROM PEARL HARBOR

Lockwood emphasized wolf-pack operations throughout the year. Most were sent to the critical Luzon Strait. The fourth wolf pack sent from Pearl Harbor arrived there in mid-April 1944 and immediately spotted and attacked a big convoy. Three days later, the three boats (*Bang*, *Tinosa*, and *Parche*) mounted a combined attack on another convoy, sinking five of ten ships. The following wolf pack, also deployed to the Luzon Strait in April, was less effective, accounting for a single sinking.

Since an invasion of the Marianas was planned for mid-1944, Lockwood also emphasized interdiction of convoys to the Marianas in the months leading to the landing. In February, two boats were directed to attack an important convoy comprised of four transports escorted by three Yugumo-class fleet destroyers carrying the IJA 29th Division to the Marianas. Veteran *Trout* (on her eleventh patrol) sank one transport and damaged another but was lost when *Asashimo* found and counterattacked the submarine. The blockade was intensified with the arrival of a three-boat wolf pack

US submarine loss
Japanese convoy routes
USSR
MONGOLIA
MANCHURIA
CHINA
KOREA
JAPAN
BURMA
THAILAND
INDOCHINA
MALAYA
SUMATRA
BORNEO
PHILIPPINES
NEW GUINEA
AUSTRALIA
PACIFIC OCEAN
INDIAN OCEAN
Kamchatka
Sakhalin
Paramushiro
Karafuto
Herring, Jun 1, 1944
Oturu
Muroran
Rashin
Golet, Jun 14, 1944
Albacore, Nov 7, 1944
Bonefish, Jun 19, 1945
Dairen
Gensan
Niigata
Tsingtao
Maizuru
Tokyo
Scorpion, c. Jan 6, 1944
Escolar, c. Oct 17, 1944
Osaka
Moji
Kagoshima
Scamp, Nov 11, 1944
Shanghai
BONIN ISLANDS
Tang, Oct 25, 1944
Grayback, Feb 27, 1944
Keelung
Shark II, Oct 24, 1944
Formosa
Takao
Hong Kong
Gudgeon, Apr 18, 1944
Trout, Feb 29, 1944
Hainan
MARIANAS ISLANDS
Saipan
Rangoon
Harder, Aug 24, 1944
Darter, Oct 24, 1944
Manila
Growler, Nov 8, 1944
Saigon
Ormoc
Robalo, Jul 26, 1944
Davao
Flier, Aug 12, 1944
Tullibee, Mar 26, 1944
PALAU ISLANDS
Truk
Medan
Morotai
Seawolf, Oct 4, 1944
Singapore
Halmahera
Balikpapan
Biak
Celebes
Hollandia
Palembang
Ceram
Rabaul
SOLOMON ISLANDS
Makassar
Amboina
Belitung
Surabaya
Java
Timor
N
0
800 miles
0
800km

in late May. These attacked four convoys, sinking seven ships overall. In the last convoy, five of seven ships were dispatched. Even though these were heavily escorted convoys, none of the boats were lost. Some of the other boats from Pearl Harbor were not as lucky. *Scorpion* was lost in January probably to a minefield in the East China Sea. *Grayback* was lost in February to a probable air attack.

Following the conclusion of the Marianas campaign, Lockwood turned his focus to the Luzon Strait. An improvised wolf pack arrived there in late June. On June 27, it attacked a convoy of five merchants with five escorts, sinking two of the merchants. Three other wolf packs patrolled this key chokepoint during the same period and accounted for 12 ships sunk. As part of the third wolf pack, "Red" Ramage commanding *Parche* conducted one of the boldest attacks of the war. On July 31, he roared into a convoy on the surface, firing 19 torpedoes while slipping between the ships in the convoy. He claimed five ships, but postwar analysis conformed that only two sank. For this display of bravery and initiative, Ramage received the Medal of Honor.

By the middle of 1944, Japanese losses were averaging 200,000 tons per month. Whether in wolf packs or on individual patrols, submarines were ripping the heart out of the Japanese merchant marine. Three boats from Pearl Harbor sank 16 ships for some 50,000 tons in July. The first formal wolf pack from Fremantle departed in June and claimed six ships for another 36,000 tons. There was a cost, though. Fremantle boat *Robalo* was lost to a minefield on July 26, and *Flier* struck a mine in the same area on August 12.

In August, four more wolf packs were sent to patrol the Luzon Strait. The second of these took on a large convoy of 12 ships with a heavy escort including carrier *Taiyo*. Six merchant ships and *Taiyo* were sunk. The wolf pack went to Saipan for more torpedoes and to reprovision, and then proceeded back to the Luzon Strait. This "double-barrel" patrol sank 13 ships in total for 65,000 tons. The next two wolf packs to the Luzon Strait accounted for another 13 confirmed sinkings for some 89,000 tons. The eight wolf packs sent to the Luzon Strait up to this point accounted for an amazing 56 ships of some 250,000 tons.

As the invasion of the Philippines loomed, most patrols, both individual and wolf packs, turned to cutting off the Philippines from reinforcement. Five wolf packs were deployed with this mission in August 1944. One pack from Fremantle headed for the East China Sea, but lost *Escolar* probably to a mine. Another Fremantle boat, *Seawolf*, was sunk by friendly forces on October 4.

The ferocity of the combat between those boats led by an aggressive skipper and IJN ASW escorts is illustrated by the exploits of *Harder*. "Destroyer Killer" Dealey did not hesitate to go after escorts as well as merchants. Harder departed Fremantle with two other boats on August 5. On August 21, the wolf pack attacked a convoy off Mindoro and sank five ships. The following day, Dealey sank two *kaibokan*. Two days later, he was chasing after a tanker when *Patrol Boat 102* (the ex-USS *Stewart* captured by the Japanese in March 1942) and *kaibokan CD-22* came to the tanker's aid. Harder apparently fired three torpedoes at the charging *Patrol Boat 102*, but missed. A nearby submarine heard 15 depth-charge explosions, which spelled the end of *Harder*. On five patrols, Dealey sank 16 merchants, four destroyers, and two *kaibokan*. He was awarded a posthumous Medal of Honor.

OPPOSITE
Principal Japanese shipping lanes and USN submarine losses, 1944.

Commander Samuel D. Dealey was awarded the Medal of Honor, posthumously, while in command of *Harder* during her fifth patrol in June 1944 when she sank three enemy destroyers and was credited with damaging two others. *Harder* was lost with all hands on her next patrol while operating as part of a wolf pack off Manila Bay. (Naval History and Heritage Command)

When the invasion of Leyte began on October 20, 1944, 30 boats were deployed around the Philippines in support. Most were continuing interdiction operations. Between October 23 and 26, *Tang* and two wolf packs accounted for 17 merchants. *Tang* was under Richard O'Kane, one of the most successful skippers in terms of ships sunk. This run of success came to an end on the night of October 24/25 when his boat was struck by one of its own torpedoes making a circular run during an attack on a convoy. O'Kane survived and was taken prisoner, remaining so until war's end.

USN submarines played an important part in the battle for Leyte Gulf fought between October 22 and 26, 1944. On October 23, *Bream* rammed a torpedo into heavy cruiser *Aoba* outside Manila Bay. The cruiser survived, but never saw action again. More important were the actions of *Dace* and *Darter* against the main Japanese force headed to attack American shipping inside Leyte Gulf. The two submarines were deployed in the southern approaches to the Palawan Passage. Gaining contact on a huge force of Japanese heavy cruisers and battleships, they raced ahead to make a submerged attack. Though escorted by 15 of the IJN's best destroyers, the two boats got into ideal position to attack the columns of Japanese heavy ships. *Darter* attacked first and put four torpedoes into the Japanese flagship heavy cruiser *Atago*, which sank quickly. A salvo from her stern tubes hit heavy cruiser *Takao* twice, inflicting heavy damage. *Dace* followed up with a salvo against heavy cruiser *Maya*; four torpedoes hit, sinking her in minutes. Trying to finish off *Takao* that night, *Darter* ran hard aground and was lost.

Other boats were tracking the Japanese carrier force operating to the north of Luzon. On October 25, light cruiser *Tama*, already damaged by air attack, was detected by *Jallao* conducting her first patrol. Two of her torpedoes hit the cruiser, which sank in minutes with all hands. As the remaining ships of the carrier force returned to Japan, they were chased by 21 submarines. No additional damage was inflicted.

More disasters befell the IJN in the last two months of the year. Two wolf packs were directed to attack a large convoy carrying a full division of troops escorted by six destroyers and escort carrier *Shinyo*. The submarines gained first contact on November 15 and proceeded to sink eight ships, including *Shinyo*. The wolf packs accounted for 19 ships in total of some 110,000 tons before returning to base. Days later, *Sealion* struck *Kongo* with a single torpedo, but the damage was sufficient to sink the battleship. She was the only IJN battleship lost at the hands of USN submarines. The largest ship ever lost to submarine attack was the 72,000-ton *Shinano*. This converted Yamato-class superbattleship was detected by *Archerfish* in the outer part of Tokyo Bay on November 29. The carrier had put to sea in an incomplete condition and could not withstand the effects of four torpedo hits. She sank with the loss of 1,435 men. The following month, American submarines

gained their last carrier kill when *Redfish* sank the new carrier *Unryu* off Luzon with the loss of another 1,235 men.

SUBMARINE PATROLS FROM AUSTRALIA

In early 1944, Brisbane-based boats were moved to Manus Harbor in the Admiralties and Captain Fife was sent to shore duty. Meanwhile, the Fremantle force was reinforced with 18 boats from Pearl Harbor, bringing the total number of boats based there up to 30. Christie continued his war against Japanese tankers with some success. A large convoy with two Imperial Army divisions with a heavy escort sailing from Shanghai to New Guinea lost four ships and was forced to unload at Halmahera, short of its destination. Christie's boats harassed the IJN's battle fleet anchored in Tawi-Tawi northeast of Borneo so consistently and effectively that it was unable to go to sea and train its inexperienced aviators. In June, Sam Dealey on *Harder* gained the title as the "Destroyer Killer" by sinking three destroyers (of the four he claimed) on a single patrol.

As the invasion of the Marianas neared, the priorities of Christie's boats changed to reporting contact on IJN movements. This was accomplished extremely well during the Battle of the Philippine Sea in June 1944. The IJN's carrier fleet departed Tawi-Tawi under strict radio silence to contest the American invasion of Saipan. The only tracking of the fleet available to American commanders was provided by USN boats. When the battle was joined on June 19–20, USN submarines struck the most important blows of the battle. On June 19, *Albacore* gained a single torpedo hit on the Japanese flagship, the new 34,600-ton fleet carrier *Taiho*, which later sank. A short time later, *Cavalla* slammed three torpedoes into Pearl Harbor veteran *Shokaku*, which also sank with heavy loss of life. The entire USN Fast Carrier Task Force could only manage to sink one converted carrier the following day.

Darter photographed aground on Bombay Shoal, off southwest Palawan, following her outstanding attack against the Japanese First Diversionary Attack Force on October 23, 1944. She went aground the following day trying to finish off heavy cruiser *Takao*. Two boats were ordered to blow up the hulk with torpedoes, but were unsuccessful. The damage shown here was caused by 55 6in. shells from *Nautilus*. (Naval History and Heritage Command)

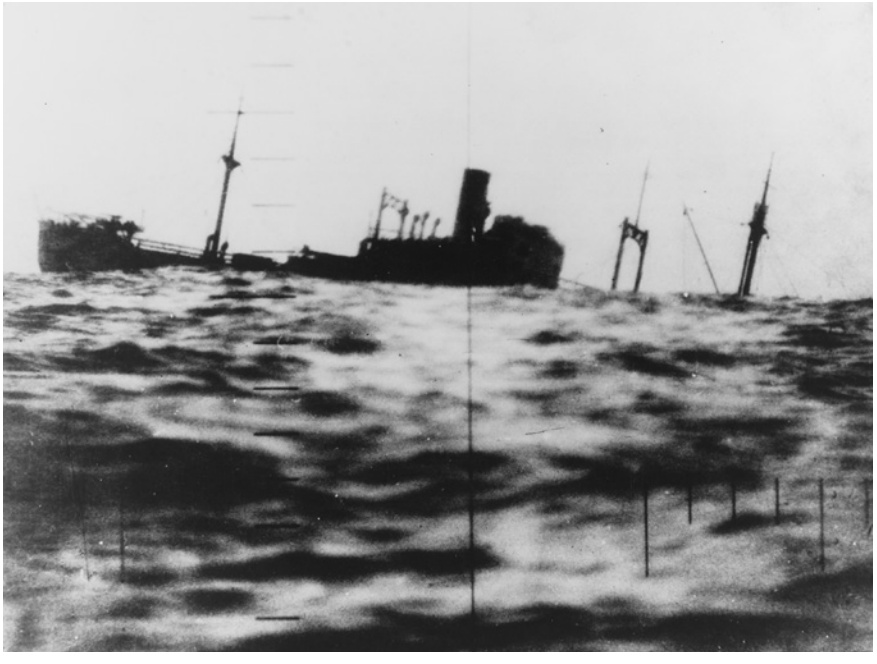
Tautog photographed on May 29, 1945. Note the scoreboard painted on her sail. *Tautog* sank 26 Japanese ships, including two destroyers and two submarines. This made her first in the number of vessels sunk and eleventh in total tonnage destroyed. (Naval History and Heritage Command)

STATISTICS AND ANALYSIS

During the first 13 months of the war, USN submarines conducted some 350 war patrols. Throughout 1942, available strength averaged 67 boats. Of these, only about 13 could be kept on patrol at any given time due to maintenance requirements and transit times. Average patrol length was six to seven weeks, and over half of this was spent in transit to the boat's assigned operational area. The war began with most submarines conducting defensive patrols, first off the Philippines, then the NEI, and later off Midway. In the first two instances, submarines were totally ineffective in the anti-invasion role. Confirmed sinkings of Japanese ships were few.

Dispersal of effort was a major reason why USN submarines were generally ineffective through 1942. Submarines were dispatched on myriad types of missions, including chasing after high-value IJN targets based on Ultra decrypts, minelaying, reconnaissance, supply runs, personnel evacuation, and even an amphibious raid on Makin in the Gilbert Islands in August—all of which took the boats off more suitable and successful missions. Major efforts were made to "blockade" Truk and the Solomons in direct and indirect support of the Guadalcanal campaign. Since these areas were heavily patrolled by the IJN, successes were relatively few.

The most successful mission type, and a portent of things to come, was shipping interdiction in Japanese home waters or the East China Sea. The Luzon Strait was a particularly lucrative area since virtually all Japanese shipping coming from the resource areas of Southeast Asia to Japan had to pass through it. The 54 shipping interdiction missions accounted for 81 confirmed sinkings—almost half of all Japanese losses.



This Japanese cargo ship was sunk by Gato-class boat *Drum*. During the war, submarine skippers made claims based on observed results with the aid of available recognition materials. The claims were reviewed and usually modified after the boat returned to base. After the war, a review panel (the Joint Army-Navy Assessment Committee) was established to match these claims with Japanese records. This was a monumental task that has provided the baseline of confirmed sinkings, with few modifications. (Naval History and Heritage Command)

In the tonnage war, 1942 was a lost year. Postwar Japanese records indicate that 180 ships were lost during this period for a total of 725,000 tons. During the year, the total available Japanese merchant tonnage (freighters and tankers combined) declined by a mere 89,000 tons. This result was even better than the IJN's incredibly optimistic prewar predictions.

There were many reasons for this failure. Three stand out as most important. The primary one was the dispersal of effort already mentioned. Another one was the most obvious—the problems with the Mark 14 torpedo. This one continued into 1943 since the issues surrounding the exploders had not even been addressed, but the problem with the torpedoes running too deep had been exposed and corrected. The final major issue was the poor performance of the submarine captains.

Operations in 1941–42 cost the USN seven submarines. Of these, only three were lost to IJN ASW action. The loss ratio was extremely favorable for the USN—45 merchant ships were sunk for every submarine lost to IJN ASW forces. However, submarines were only accounting for about one merchant sunk per month on patrol. Only one attack in four was successful. Three submarines were lost to grounding, and the final boat to air attack. The failure of USN submarines to run up large scores on virtually undefended Japanese shipping camouflaged the fact that for more than a year IJN ASW units accounted for only three USN submarines.

The lethality of the USN's submarine force greatly increased in 1943. The SJ radar was in full service, the quality of Ultra intelligence was better, the issues with the Mark 14 were being resolved, and many ineffective skippers had been weeded out and sent to shore commands. Tactics were also evolving with the first tentative use of wolf packs late in the year. In addition, boats were sent to areas where the prospects for success were greater. Changing deployment tactics were most apparent

This is Gato-class boat *Growler* photographed on February 21, 1942 before her commissioning. On 11 patrols, she sank ten Japanese ships, including two destroyers and *kaibokan Hirado* before being lost with all hands on November 8 due to an unknown cause. (Naval History and Heritage Command)

with Lockwood's boats out of Pearl Harbor. In 1943, about 50 percent of boats went to Japanese home waters and the East China Sea as opposed to 15 percent the previous year.

The bottom line was that sinkings rose to 335 ships for a total of 1.5 million tons. More than 100,000 tons of Japanese shipping were being sunk each month, rising to a year-high total of 231,000 tons in November. This began to impact imports to support the Japanese war economy. In 1943, 16.4 million tons of bulk commodities arrived in Japan compared to 19.4 million tons in 1942. Sinkings were now greater than the capacities of Japanese shipyards to replace them. Overall shipping tonnage decreased from 5.2 million to 4.1 million tons. Despite an effort to focus on tanker attacks by the Fremantle submarines, overall Japanese tanker tonnage increased by 177,000 tons during 1943. Japanese ASW efforts were also more effective in 1943, at least based on the number of USN submarine losses. A total of 15 were lost during the year—seven from Pearl Harbor or in the Aleutians, four from Brisbane, and four from Fremantle. This still meant that over 22 merchant ships were sunk for every submarine lost. One in three attacks was successful from the average of 18 boats on patrol each month. For each month on patrol, boats averaged two ships sunk.

The year 1944 provided a display of the destructive potential of USN submarines. It is no understatement that despite the best efforts of IJN ASW forces, the shipping war in the Pacific was decided in 1944. The expanding USN submarine force (which began the year with 123 boats and ended with 156), using advanced bases at Biak and the Marianas, conducted 520 patrols in 1944. By focusing on the Luzon Strait chokepoint, submarines strangled trade from Southeast Asia to Japan.

Postwar analysis confirmed the loss of 603 Japanese ships for a total of some 2.7 million tons. In January 1944, the 27 boats on patrol sank 50 ships of close to 250,000 tons. This total was matched in May by the 35 boats on patrol. October was the highest-scoring month of the war when the 43 boats on patrol sank 68 ships totalling 328,000 tons. By the end of the year, the Japanese merchant fleet was

reduced to about 2 million tons; available tanker tonnage was reduced to 869,000 tons. Those ships remaining were no longer free to conduct normal commerce or give support to the Japanese military since they were forced to spend 1945 in confined waters or hugging the coast to avoid submarine attack. The result of this precipitous decline in shipping was that imports of commodities essential to the Japanese war economy went from 16.4 million tons in 1943 to some 10 million tons in 1944. This meant crippling shortages in Japan. Most disastrous was the petroleum situation for the Japanese. The American focus on sinking tankers continued into 1944—21 were sunk during the first two months of the year. By May, oil imports to Japan were reduced by 50 percent, and by the end of the year oil imports collapsed.

In addition to the toll on Japanese shipping, USN submarines also conducted effective attacks on the IJN itself while rendering important assistance to USN operations. During 1944, USN submarines accounted for seven carriers, one battleship, nine cruisers, and 30 destroyers.

IJN ASW forces were swamped by this assault. As Japanese convoys were ravaged, their escorts were powerless to intervene. Ineffective as escorts, IJN escorts were reduced to being rescue ships. While total USN submarine losses rose during the year to 19, few were at the hands of IJN escorts. During the year, over 40 merchant ships were sunk for every USN submarine lost. One submarine attack in three was successful, with American submarines accounting for an average of 1.5 merchants for each month on patrol.

The USN's submarine force was the most effective and deadly component of the entire navy. At its peak it consisted of about 230 submarines and just over 17,000 men. This comparatively small force sank 1,113 Japanese merchant ships of 500 tons

Kete, a Balao-class boat, shown in August 1944 during trials. The boat is equipped with a single 20mm mount forward and aft of the bridge. Later, 40mm guns replaced one or both of these mounts. *Kete* was lost on her second patrol sometime after March 20, 1945 after claiming three small ships sunk in an attack on a Japanese convoy. As is the case for several submarines, the cause of her loss remains unknown. (Naval History and Heritage Command)

Patrol Boat No. 39 was sunk by *Seawolf* on April 23, 1943 off Formosa. The Momi-class destroyer was converted to a patrol boat before the war, and then into a fast landing ship able to carry landing craft, demonstrated by the ramp on the stern. (Naval History and Heritage Command)

or greater with a total tonnage of 4,779,902 gross tons—55 percent of all Japanese shipping losses. In addition, USN submarines sank 214 IJN ships. The submarine force lost a total of 52 submarines from all causes and just over 3,500 men. Since these losses came from 16,500 personnel who conducted a total of 1,682 patrols, this constituted the highest loss rate in any branch of the USN.

Despite the losses suffered by the USN's submarine force, the IJN's overall ASW effort during the Pacific War can be described as ineffective. The reasons for this have already been described, but one of the main explanations was a lack of escorts. After a late start, the IJN was able to get 173 *kaibokan* into service. However, many entered service too late to have an impact. Overall, the *kaibokan* was a mediocre ASW platform. Their lack of speed and effective weaponry made them ineffective submarine hunters, and by 1944, they were also demonstrating that their inferior antiaircraft capabilities made it difficult for them to operate in areas increasingly dominated by US airpower. The early *kaibokan* designs were unsuited for mass production, which meant most arrived too late. IJN escorts, with their rudimentary sensors and ineffective weapons and manned by inferior crews, proved unable to deal with USN submarines, which were equipped with world-class sensors

Table 26: IJN ASW escort losses

Class	Total built	Number lost	Lost to submarines
Wakatake	8	8	5
Tomozuru	4	3	1
Otori	8	7	4
Shimushu	4	1	1
Etorofu	14	8	6
Mikura	8	5	4
Ukuru	29	8	5
No. 1 (Type C)	53	27	12
No. 2 (Type D)	63	26	12

and reliable weapons, commanded by aggressive officers, and supplied with excellent intelligence on the movements of Japanese convoys. Table 26 illustrates the heavy losses suffered by IJN ASW escorts.

In return for the destruction of Japanese trade and the massacre of IJN ASW escorts, the USN lost a total of 52 submarines during the war, all but two in the Pacific. Breaking this down by cause, which remains difficult even to the present day due to lack of information and conflicting sources, shows the relative ineffectiveness of IJN ASW forces.

Of the 52 subs lost, a maximum of 43 were lost to Japanese forces. The principal causes, where known, are listed in Table 27. The eight boats lost to unknown causes were all likely lost to mines or to other Japanese forces, but the exact reasons remain unclear. Sixteen were lost to IJN surface forces, with destroyers accounting for the most and *kaibokan* only five. Mines were the single greatest cause of loss, and the total shown does not reflect the additional boats lost to mines, which are shown as unknown.

Table 27: Losses of USN submarines by principal cause

IJN submarine	1
IJN destroyers	7
IJN *kaibokan*	5
Other IJN surface forces	4
Aircraft	6
Shore battery	1
Mines	8
Unknown	8
Friendly fire	3
Defective torpedoes	3
Accidents	6
Total	**52**

By 1944, USN submarines had established absolute superiority over IJN ASW escorts. Even heavily guarded convoys were routinely ravaged by submarine attack, resulting in the loss of most of the merchants in the convoy. This technical superiority over IJN ASW escorts was most marked against the mediocre *kaibokan*. In general, Japanese escorts were unable to cope with the high speed, large torpedo capacity, and sophisticated radars of USN boats. Evidence of this imbalance is provided by the loss ratios between submarines and escorts. Against the ASW escorts covered in this book, over eight escorts were sunk by submarines for every submarine lost to attacks from the same escorts. Even against the IJN's destroyer force, the most proficient IJN ASW ships, 39 destroyers were sunk by USN submarines in exchange for seven submarines. The superiority of USN submarines against IJN ASW escorts of all types was a huge factor in deciding the shipping war in the Pacific.

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In addition to ravaging Japanese shipping, USN fleet boats executed great damage to the IJN itself. The first major IJN warship dispatched by American submarines was heavy cruiser *Kako* (shown here in 1940) sunk by *S-44* in August 1942. Before the war was over, USN submarines sank eight Japanese carriers, one battleship, three heavy cruisers, and nine light cruisers. (Naval History and Heritage Command)

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In most cases imperial measurements, including nautical miles (NM), knots (kn), and long tons, have been used in this book. For ease of comparison please refer to the following conversion table:

1NM = 1.85km
1yd = 0.9m
1ft = 0.3m
1in. = 2.54cm/25.4mm
1kn = 1.85km/h
1 long ton = 1.02 metric tonnes
1lb = 0.45kg

Title page photo: *Patrol Boat No. 39*, a Momi-class destroyer, sunk by USS *Seawolf* on April 23, 1943 off Formosa. (Naval History and Heritage Command)
Front cover, above: A submerged USN Gato-class submarine. (Ian Palmer)
Front cover, below: A Japanese No. 1 Class (Type C) antisubmarine warfare ship making a depth-charge attack on a US submarine. Its depth charges are being fired from the Y-guns on the fantail. (Ian Palmer)